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# NEW FRONTIERS IN PARTICIPATORY RESEARCH AND GENDER ANALYSIS

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## Natural resource management working group

# INTRODUCTION: SYNTHESIS OF DISCUSSION IN WORKING GROUPS[1]

Enhancing the participation of users—especially poor rural women—in the process of technology development for small farmers is an important strategic research issue, vital to achieving an impact that benefits poor people. Household food security (and child food security) is strongly linked to women's access to income-generating technologies. User participation in the early stages of technology design ensures that new technologies can be adopted rapidly. The "feminization of poverty," a trend which is driving rural women in particular to form an increasing proportion of the very poor, makes it imperative that a high priority be given to strengthening, consolidating and mainstreaming both participatory research and gender analysis (PR/GA) in international, national and local agricultural research.

From September 9-11, 1996 a group of fifty researchers and development professionals attended an international seminar and planning meeting in Cali, Colombia to identify methodological issues in PR/GA needing further research, and to set in motion a research program on PR/GA approaches for different technologies and socioecological contexts. They represented IARCs, NARIs, universities, NGOs and donors, and came from Asia, Latin America, Central America, Africa (east, west, south and north), South and Southeast Asia, the Middle East and Europe. Farmers were not present, although the conference organizers thought hard about how farmers might be included in a meeting conducted in the languages of English and specialized science. Inviting a few local farmers or selected heads of farmers' organizations (most of whom have little truck with research) seemed neither meaningful nor dignified.

While all present at the meeting had a keen interest in PR/GA approaches, not all were convinced of their utility. As one research manager commented in reference to participatory plant breeding (PB): "Is this a positive response to a new opportunity or a backlash caused by an institutional breakdown? It's clear that classic breeding hasn't addressed the problems of marginal environments. But do we need participation—or simply a breeding program which starts to do its job properly?" With the stimulus of this debate, participants scrutinized the rigor of current approaches, weighed their costs and benefits, and identified important gaps for consolidating existing experiences as well as scaling up the use of effective approaches.

The proceedings of this meeting present the participants' reflections on key questions for understanding the usefulness of participatory research and gender analysis in the process of technology development. All told, the participants represent literally hundreds of years of PR/GA experience. The papers they were invited to present were designed to be a stimulus to debate and analysis. Speakers were asked to reflect on the unresolved problems or challenges

[1] The introduction is a synthesis of working group discussions recorded daily, and rapporteur notes reported by Jacqueline A. Ashby, Louise Sperling and Diana Carney.

of PR/GA along a systematic set of themes. The reflections were asked to be critical, provocative, and based on felt needs arising from practical experience: for R&D in communities; for defining international and national research programs; and for shaping policies that determine what type of research paradigms need to be institutionalized.

This introduction is divided into two major sections. The first one highlights five of the more general conceptual issues with which participants grappled. These helped prepare the stage for papers and substantive discussions on challenges faced by researchers using PR/GA approaches. The second part outlines the agreed-upon research agenda in several areas: participatory methods in plant breeding (PB), in natural resource management (NRM), and gender analysis (GA), specifically as it cross-cuts PB and NRM.

## Key Issues

### *Participation: What's the Bottom Line?*

One of the most compelling debates during the meeting concerned the rationale for 'participation'. One goal of encouraging farmer participation in research is to improve the functional efficiency of formal research (better technologies, more widely adopted, more quickly). Another objective of participation is to empower marginalized people and groups so that their own decision making and research capacity is strengthened and they can make effective demands on research and extension organizations. The two are not mutually exclusive: functional participation can be empowering, and empowering participation may lead to functional efficiency gains in technology development. However, the two may imply different spending priorities and time horizons. The quest for empowerment generally demands more intensive participation over a longer time period than the quest for functional efficiency gains in a particular research area. The two approaches also imply different criteria for success. Cost effectiveness is a key criteria of success in functional participation, whereas capacity building is a more important result for empowering participation.

The issue of when and why empowerment as an objective of participation was thoroughly analyzed. Some participants took the view that formal research programs do not need to be concerned with empowerment, nor was it in the scope of the international agricultural research centers' mandate. Another view was that effective functional participation could not take place without empowerment, and that the involvement of NGOs with a track record in empowerment would strengthen any effort to use participatory approaches to agricultural technology development.

As a result, empowering and functional participation will receive attention in the initiative's empirical studies. Better understanding will be sought of the practical differences—and consequences—of the two perspectives, both for the formal the research system and for all the stakeholders.

*Identifying and Working with Stakeholders*

"Stakeholders" refers to all those who might help shape a research agenda, be directly involved in carrying out research, or who are going to be affected by, or use, the results of the research. Using this definition, a huge range of potential stakeholders can be associated with the development of technology, and different groups may be allied with different research stages. (For example, in participatory plant breeding, consumers and middlemen are involved later in the process than farmers). As it is not feasible, (nor probably equitable) for each stakeholder group to cast a single vote at each stage, some hard choices need to be made about who participates, and at what stage, and what weight is to be given to different groups of stakeholders. A number of questions related to this issue preoccupied the participants in the meeting.

The first question concerned the degree of stakeholder differentiation needed to get a useful product. Do all potential categories of stakeholders have to participate directly in research to get products which they will find specifically useful? Do all need to be involved during the full sequence of research (i.e. priority setting, experimentation, evaluation)? Within stakeholder groups, should participatory programs aim to work with a representative set (of users) or would a focus on involving users with specialized expertise give more targeted results—in terms of efficiency?

The second issue centered on the costs of differentiating stakeholders and conducting research with different groups. Is it more expensive to consider the needs of six differentiated stakeholder groups than of two? Are the costs of differentiating users outweighed by differentiated benefits? Are there cut-off points for the aggregation or disaggregation of stakeholders which yield the maximum benefits? Are the cut-offs different when the program is aiming at equity or empowerment than when its goal is research efficiency?

Third, the group debated the kinds of methods and mechanisms which are available for addressing concerns of stakeholder differentiation. Do we know how to identify effectively the full range of stakeholders? Do we have tools to ensure the participation of 'invisible groups' (such as women, in some cultures)? How can participatory processes be managed when there is conflict among stakeholders? This is a big issue, particularly in managing larger natural resource units, such as watersheds. Are there methods for measuring how the inclusion of different stakeholders affects the outcome of research? Are there mechanisms which should be put at the disposal of stakeholder groups themselves so as to make their participation effective (e.g., research funds or opportunities to sit on influential committees?) Although, in answer to many of these questions, participants could make inventories of possible tools, methods, and mechanisms on offer, few felt that the options had been rigorously evaluated. How can adequate "quality control" be exercised on existing tools? Are the well-developed gender-analysis tools equally applicable for other variables which differentiate users? Is there an inherent bias in certain tools towards "extractive" applications? Does this matter for the outcomes of functional participation?

In all these concerns—the degree of differentiation needed, the cost-benefit ratio of differentiation, and methods for looking at both—the questions asked are different depending on whether the objective is functional participation or empowerment. In the process of technology development, an empowerment focus might be more inclusive: "Everyone should take part". A functionalist approach will be more selective: for example, "Only farmers who are seed experts really need to screen germplasm." The question then follows: Are the benefits of technology development distributed more or less widely depending on the "functional" vs. "empowerment" approach to participation in the research?

*Experimental Methods: Where's the Starting Point?*

The nature of the interface between scientists' and farmers' experimentation was also a concern denoted throughout the workshop. There was agreement that both are important and that bringing the two together can be a stiff methodological challenge. However, opinions about the starting point for research, and the weight of each set of techniques, differed. Should research begin by identifying farmers' own experimental practices and then build on these, strengthening them through the application—where relevant—of techniques derived from formal science? Or, should formal experimentation be the starting point for research into which farmer involvement is then introduced?

It was evident that these two points of departure need not be mutually exclusive, and could have different advantages, depending on the research issues and institutional context in question. Starting with farmers' own experimentation might be more advantageous in participatory NRM research or in the generation of knowledge- intensive or management-intensive technologies.

Conversely, in participatory plant breeding it may be advantageous for farmers to incorporate some formal crossing and screening methods into their own varietal improvement. Participants agreed that one of the contributions of this initiative would be to provide guidelines on the basis of empirical case studies of different starting points.

The participants' analysis of the advantages of building on farmers' own experimental methods versus those of relying on a formal research paradigm converged with their discussion of farmer involvement in prototype testing or pre-adaptive research. Table 1 shows how two of the working groups assessed results to be achieved by research using these two very different starting points. The similarities in each analysis of the expected results are striking and need to be explored more thoroughly. One important comment was that in prototype testing, it is difficult to say exactly 'whose' research is being built on.

*Impact: What is Being Assessed?*

By bringing scientists and development practitioners together, the meeting identified a common concern: the need to evaluate the impact of participation and gender analysis, both

**Table 1: Conclusions of two discussion groups on the expected results of joint farmer-scientist research with different starting points***

| Discussion group on results of farmer involvement in pre-adaptive formal research | Discussion group on results of scientists participation in farmers' research |
|---|---|
| **Similar conclusions** | |
| • Incorporation of farmers' knowledge into research agenda (building on indigenous knowledge)<br>• Early farmer perceptions of "what is possible"<br>• Reduce the number of years from beginning a research to adoption<br>• Use research budgets more cost-effectively—"more and cheaper" research<br>• Mutual trust and respect | • Technology based on farmers' indigenous knowledge<br>• Early benefits of farmers' insights and observations<br>• Quicker solutions to "real" problems<br>• More efficient and effective use of resources<br>• Better relations with farmers |
| **Different conclusions** | |
| • Portfolio of solutions/multiple options<br>• both local and exotic | • Validation of value of farmers' research and local technology by scientists |

* Conclusions have been edited to present the main themes.

for end-users and for the efficiency of the research process. While seminar participants only touched on specific procedures for evaluating participatory field research and the impact of the initiative as a whole, they did raise fundamental questions which will shape the evaluation of impact.

There was a debate among the participants about whether the primary impact of participatory research is embodied in a product—such as a better set of adapted technologies or a more efficient research organization—or in a process, such as the strengthened ability of a community to solve their own problems. The definition of outputs has implications for determining impact, and also for determining exactly what needs to be scaled up: the learning process itself or the products emerging from participatory research? Discussions showed that impact may be defined as both the process and the product: one of the conclusions of the NRM research group was that the "product" might be a knowledge-intensive technology which requires a participatory learning and management processes for farmers to use it.

Another issue related to defining impact was the relative importance of achieving local or site-specific impact vs. extracting generalizable lessons and methods. There need not necessarily be a conflict between the two objectives. Thorough, site-specific research can both deliver immediately useful products and involve rigorous analysis of methods used and general lessons learned. As research budgets are generally falling, attention to both results (site-specific impact) and methods which help achieve those results would seem to go hand in hand. This means that the costs of participatory research and gender analysis need to be related to the benefits. If the cost of this new paradigm puts it out of reach of all but the most well-endowed research institute or system, then it is a luxury. This is a danger that must be consciously guarded against.

*Scaling Up and Institutionalization: Two Heads of the Same Snake?*

Achieving impact, scaling up and institutionalizing participatory approaches and gender analysis were seen as intimately linked. Indeed, some participants proposed that impact indicators be devised according to whether an approach could or could not be scaled up. Cost-benefit ratios also, it was suggested, need to be multiplied by the scale on which the PR/GA approaches will ultimately be used in order to get a full assessment of research efficiency. Start-up costs may be high, both in terms of methodology development and initial entry into a pilot community. However, some suggested that replications might be less costly if PR/GA research were to be implemented in many locales. This still needs to be proven.

There were very varied perspectives expressed in the meeting on the interdependency between scaling up participation and institutionalization. Some participants conceived of the research procedure as a series of discrete steps: i.e. first, get the methods right, then institutionalize them, and third, work on scaling them up. Another perspective suggested that methods developed first at a small-scale may not be suitable for scaling up (they may, for example, be too labor intensive, with few economies of scale). From the beginning, techniques, organizational models and research methods may have to be developed at the scale at which they will ultimately be used. For example, would a PR approach be multiplied by adding more small groups on the same scale as the initial groups worked with; or would it be multiplied by expanding the approach used with a few small groups to a larger, watershed-scale group; or would it start out at the scale of involving all the relevant stakeholders in a large-scale participatory effort, for example, in a whole watershed?

Are institutionalization and scaling up the same? Certainly, methods can be institutionalized, that is, they can be made routine, but remain restricted to a very few sites or themes. Does effective institutionalization, imply *widespread* use of the approach and require scaling up? One of the challenges for this initiative is to analyze separately the degree to which methods and approaches have been institutionalized and the degree to which they have been scaled up, and the critical success and failure factors for each.

## Opportunities and Challenges for Future Research

The section below outlines the precise research directions which participants in the Cali meeting felt needed to be taken further in three substantive realms: participatory plant breeding; participatory research in natural resource management and gender analysis. Their goal is to create a set of worldwide comparative studies which will address the needed methodological issues across crops, farming systems, populations and socioenvironmental contexts.

*Participatory Approaches in Plant Breeding*

The incorporation of participatory methods into plant breeding began in the mid-1980s when farmers were invited to become involved in the evaluation of pre-release materials. The gap between users' and breeders' criteria for acceptability of new plant types identified through participatory research is now stimulating plant breeders to introduce user participation at still earlier stages in applied research. The effects of this are marked; some breeders perceive participatory methods as comparable to biotechnology techniques in terms of their potential for opening up new frontiers in breeding (Kornegay et al., 1996; Ceccarelli et al., 1995; Zimmermann, 1996; Hardon, 1995; Iglesias and Hernández, 1994).

The working group on participatory plant breeding at the Cali meeting included many active practitioners involved in participatory plant breeding (PB) programs such as: ILEIA's (the Information Centre for Low External Input and Sustainable Agriculture's) work supporting farmer rice breeding in the Philippines; the Ecuadorian national program's innovative participatory selection approaches for potato; and ICRISAT's (International Crops Research Institute for the Semi-Arid Tropics') collaborative work with Indian NGOs in screening segregating pearl millet materials with poor farmers in Rajasthan. This was the second formal meeting bringing together PPB practitioners, the first being sponsored by IDRC (the International Development Research Centre, Canada), FAO, IPGRI (the International Plant Genetic Resources Institute) and the Centre for Genetic Resources, The Netherlands, in July 1995. Many participants had attended both and thus were already familiar with each other's work; this allowed the group to identify a focused work plan in a relatively short period of time.

**Assessing participatory breeding methods.** The plant breeding group identified four major thrusts for the global research program. The first is to assess and develop participatory breeding methods themselves. Most of the existing applications of participatory approaches in plant breeding involve farmers in relatively downstream selection of advanced lines or finished varieties. Pre-adaptive participatory research in breeding is an area in which methodologies are still incipient; at present it is difficult to determine the degree of user participation that is appropriate at a given stage in the breeding process and in any given environment.

To develop methodological guidelines targeted at specific types of crops (for example, self pollinated, open-pollinating or clonally-propagated) and specific environments, the working group proposed a series of comparative empirical studies. These will involve farmers in selecting parents, in making selections from segregating populations, in evaluating advanced lines on-station or on-farm, and in decision making about the production of preferred varieties of seeds. At each stage in this process, the different selections made by breeders, men and women farmers (and perhaps other stakeholder groups, if relevant) can be contrasted. Once farmer selection strategies are understood, ways in which breeders can help to support and enhance these can be developed. One set of empirical studies will explore how farmers can most effectively be involved in the formal research process, a second set will look at the role of scientists in strengthening farmers' own breeding efforts.

**User and gender differentiation in the seed technology development chain.** Secondly, the plant breeding group suggested that a more critical look should be taken at the issues of user differentiation and gender analysis all along the seed technology development chain. Those involved include direct users of seeds, seed producers, processors of resulting crops and final consumers. At present, not all ongoing participatory breeding projects have been incorporating gender analysis and user differentiation into their work, despite the fact that it is recognized by most that women are often the plant breeders in small-farm production systems. They are responsible for domesticating wild species, selecting germplasm and saving seed. The need to better differentiate just *which users should be involved in the research process* and to specify *which users and stakeholders actually benefit* from research was identified as one of the most important cross-cutting methodological challenges of this novel initiative.

**Organizational options and decentralization of plant breeding.** For research to be effective, it is necessary not only for methods, but also for organization, to be appropriate. User participation may require that research must be decentralized in order for user groups to be involved and to meet the demands of site-specific adaptation. Therefore, as a third thrust, the plant breeding working group will explore different organizational options, including alternate divisions of labor within the breeding process. Studies in this area will assess the cost-effectiveness of different ways of organizing participatory plant breeding and the implications of increased involvement by different partners: for instance, what might be the advantages or constraints for each collaborator if farmers' groups or NGOs take a lead role in adaptive research? Certainly, this will vastly increase the scale of testing which is feasible, but the costs attached to such a strategy need to be better understood before it is widely operationalized.

Decentralization may be the *sine qua non* for participation but a number of questions about its implementation urgently need to be answered. For example, what degree of decentralization is required for tackling a particular plant breeding problem and environment? What are the financial and logistical means by which decentralization can be achieved? What are the new skills required for the management and implementation of a decentralized participatory plant breeding program? What are the implications of decentralization for research quality?

**The products of participation and support services.** Finally, the plant breeding working group proposed looking at the implications of decentralization for the design of seed support services. If resource-poor farmers are to benefit, it is not enough just to alter the orientation of technology development itself. The distribution systems which move the products of participatory breeding must also take new shape. The focus will be on finding ways of strengthening and working with local seed systems and seeking opportunities for collaboration between formal and informal seed systems.

Some of the expected outputs from research conducted by the plant breeding working group appear in Box 1.

**Box 1: Specific outputs from methodology and organizational development in participatory plant breeding**

- Participatory research methods and gender analysis tools developed suitable for integrating farmer crop-development systems with advanced breeding techniques.
- Participatory breeding strategies refined for a cross-section of species, with guidelines developed on appropriate breeding populations, field techniques, and suitable biotechnology tools.
- Knowledge and skills of rural men and women specialized in germplasm management are recognized, strengthened and linked to research.
- Varieties acceptable to farmers which incorporate traits derived from local landraces and global germplasm developed.
- Cost-effective organizational forms for different kinds of decentralized plant breeding research identified.
- Analysis conducted of the ability of the formal and informal seed sector to deliver the products of participatory plant breeding.

*Participatory Approaches in Natural Resource Management Research*

Until the meeting in September 1996, participants in the Natural Resource Management (NRM) working group, unlike the plant breeding group, had never before come together to consider the relevance of available participatory research and gender analysis methods to NRM research. This, and the generally broader and less well-defined subject area which was under discussion, meant that the group undertook a wide-ranging discussion of priorities for action.

**Stakeholder groups, collective action and conflict resolution.** Like the plant breeding group, the NRM group saw participatory methods and gender analysis as critical for mobilizing local knowledge and users' criteria—which may often be women's knowledge and criteria—in order to make decisions about the acceptability of technologies. Some of the toughest methodological challenges for participatory NRM research are concerned with how to link farmers' knowledge and interests with those of other stakeholders at different scales (from the field to the farm, community, and supra-community or watershed level). Stakeholders must first be identified, then mechanisms which enable them to contribute to the research process need to be developed. It is highly likely that conflict will develop between different stakeholder groups and thus conflict resolution techniques and skills will be at a premium.

Overall, the NRM research working group focused on issues relating to the *management* of natural resources by various individuals and stakeholder groups, rather than on the material technologies themselves. NRM technologies (such as soil conservation practices, nutrient management and integrated pest-management techniques) are often knowledge-based, management-intensive and require collaboration or collective action if they are to be effectively employed. Where there is a diversity of microenvironments and stakeholders, solutions to resource management difficulties are largely situation-specific. Arrangements which are mutually beneficial with trade-offs acceptable to the different stakeholders must be tailored to the local environment. This highlights the importance of local-level capacity development. Local people must be able to develop sustainable institutions to manage collective action and must also be in a position to analyze resource constraints, to monitor evolving resource processes and to adapt strategies for technical innovation to changing environments over relatively long periods of time.

**Impact measurement.** The NRM working group related this concern with management to impact measurement. Measuring the impact of participation is considerably harder in natural resource management research than it is for plant breeding, both because of the nature of the technologies themselves (which are often effective only as part of an entire system of management) and because of the time scale over which they would be expected to reap fruit (which may be a longer period than it takes to develop and disseminate new varieties). The long-term nature of resource management research adoption and impact makes it particularly vital that participatory evaluation mechanisms are developed and refined to sustain adoption. Farmers themselves must be the judges of success over the longer term. Thus enhancing the capacity and understanding of cause-and-effect relationships by farmers must be a priority for participatory methods applied in a learning process approach. The NRM working group linked this focus to the need for better methods for facilitating an interface between formal science and farmers' own experimentation.

**Learning and scaling up.** The NRM working group signaled that participatory methods and the participatory research process have to create a *joint learning environment* between scientists, farmers, and other stakeholders as well as among different categories of resource users. This iterative research and development process is particularly important in natural resource management research because of the complex range of trade-offs between conservation and productivity which it entails, and because of the high potential for conflict among stakeholders.

Scaling up participatory approaches to the development of knowledge-intensive technologies, was identified by the NRM research working group as a major methodological challenge and organizational issue. The group's emphasis on the objectives of participatory research as learning by doing—both on the part of researchers and farmers—raised as a major challenge the issue of whether concrete technologies would be replicated on a large scale at reasonable cost using participatory approaches. Experiences with participatory technology transfer, especially using farmer-to-farmer approaches, give some idea of how this might be done. These also underline the importance of working with, and building on, existing local knowledge systems, and of giving support to local experimentation.

Some of the expected outputs from the work of the NRM working group appear in Box 2. The group noted that new methods are expected to be developed only where existing methods are not satisfactory.

**Box 2: Specific outputs from methodology and organizational development in Natural Resource Management research**

- Methods assessed and developed for user participation in design of knowledge-intensive technologies.
- Methods for short- and longer-term resource monitoring by farmers as well as researchers.
- Methods assessed and developed for encouraging collective action, conflict resolution and negotiation at different scales.
- Technologies acceptable to farmers for increasing productivity while protecting the environment.
- Options for organizational innovation and links for managing natural resources at different scales.
- Strategies for strengthening and catalyzing local and durable organizations which can lead site-specific management of resources.
- Strategies for scaling up knowledge-intensive technology development and ensuring its spread.

*Gender and Other Categories for User Differentiation*

Participants in the meeting agreed that the differentiation of categories of users—both in the participatory research process itself and in assessing its benefits—should run as an integrated thread throughout both the plant breeding and the natural resource management research.

While user differentiation in general is important to this initiative (it has already been mentioned in both the plant breeding and NRM research workplans), the greatest emphasis will be placed on gender differentiation, catering to the needs of women as a group and to different categories of women, where relevant. Such analysis promotes both equity (in terms of access to the benefits of research) and the much-needed empowerment of rural women.

The vital role that women play in agriculture and food security in developing countries cannot be sufficiently emphasized. Women account for more than half of the labor required to produce the food in Asia, and as much as three-fourths of the labor in Africa. In most farming systems they are fully responsible for post-harvest operations, seed selection and preservation, and food processing activities. With increasing male migration in search of non-farm employment, the role that women play in farm management has also been growing. Though these facts are widely accepted and understood, there has, as yet, been too little effort placed on developing and institutionalizing methods of analysis which can systematically identify research objectives and criteria to meet women's needs.

In both the plant breeding and natural resource management groups, there was discussion of whether method development or ensuring that existing methods are used more effectively was the more pressing issue. The gender working group identified two main opportunities for method development.

**Deciding who participates.** First, methods are needed which will enable user groups to assess, rapidly and for themselves, who amongst them should participate in technology development. Rapid self-diagnosis needs to be made of the relevance of different attributes (such as wealth, age, gender, or particular expertise) for participation in research. Groups must also be able to determine whether separate or mixed groups of participants are more likely to ensure reliable user input to a given technology. In some regions, in which this is a new experience or there are specific constraints, appropriate methods must be developed to engage women's participation.

Second, methods are needed to enable users to monitor gender-differentiated effects—or, in other words, to conduct gender-differentiated cost benefit analyses—of introducing new germplasm or resource management practices. Participatory diagnosis, monitoring, and *ex-ante* assessment of the likely impact on different user groups can provide powerful feedback to research in a low-cost fashion.

Comparison of results obtained in the plant breeding and NRM empirical studies—with and without the application of gender-sensitive participatory research methods—will provide solid evidence of the value-added effect of identifying and including particular groups. It is hoped that the `proof' provided by well-designed comparative studies will be more generalizable than that provided by previous isolated case studies. The discussion-opener on gender analysis reminded participants that despite much case-study evidence of the value of incorporating such analysis as a systematic element within the research process, many scientists remain to be convinced; `proof', it is felt, does not travel well from one case to another. If the research program can help overcome this problem, it will already have made a valuable contribution in the area of gender analysis.

**Next Steps**

As these proceeding go to press, field programs in Asia, Africa and Latin and Central America and the Middle East are already being initiated to explore the cutting-edge issues in participatory research and gender analysis (PR/GA) which form the rationale for this comparative research program. A Steering Committee composed of joint partners—NGO, NARS and IARC representatives—has been formed to guide the overall agenda, and mini-workshops—among farmers—are being planned to ensure that farmer experts in the South are given a voice in the how, whens and whys of the global PR/GA research debate.

While the methodological and institutional issues being addressed in this emerging "Systemwide Program" are formidable, participants believe that the sharp focus on the "how to" of participatory research should deliver practical, targeted guidelines on when to use the varied and developing PR/GA strategies. Guidelines can only emerge from rigorous evaluation of the technical, social and economic impacts of diverse methodological and institutional options—and comprehensive evaluation of the usefulness of PR and GA is being built into the heart of the program strategy. Impact workshops on PR/GA are being organized, and evaluation components are being integrated into many of the field research programs. It is with open, critical and inclusive eyes that this PR/GA program takes its next steps forward.

# WHAT DO WE MEAN BY PARTICIPATORY RESEARCH IN AGRICULTURE?

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## Introduction

"Participation" and "participatory" have become such fashionable terms recently that any kind of activity involving a group of people is termed "participatory." As these terms embrace a multitude of meanings, and their meaning becomes correspondingly dilute, a serious threat is posed to the use of the term "participatory research." This is the threat of trivializing an approach which, in its more rigorous forms, fundamentally challenges the conventions of western empiricism which still underpins most applied agricultural research, and which has demonstrated the potential to revolutionize the way in which public-sector agricultural research serves resource-poor farmers in difficult environments. The risk is that a catch-all definition of participatory research is destined to fall out of fashion and to be discarded as fashion changes, without ever receiving the serious scientific evaluation of its potential that a rigorous but less trendy use of the term would invite.

Concern about this risk is a major reason for convening this meeting as is the proposition that efforts need to be pooled globally among the multifarious practitioners of participatory research, to ensure that when the fashion for everything participatory changes—as it inevitably will do, the valuable contributions of this approach have been well documented and are not discarded without there having been a serious assessment of their impact. The objective of this short paper is to stimulate discussion and a closer definition of "What do we mean by participatory research in agriculture?" in order to make the case that a serious evaluation based on greater clarity in the definition of what is meant by participatory research has much to contribute to defining the new frontiers with which this meeting is concerned.

The paper begins with an overview of the issues that need to be considered when we ask the question "What do we mean by participatory research?" Each of these issues will be considered in turn, and in conclusion their implications in terms of the need for evidence and for the future directions of research, are considered.

## What Do We Mean by Participatory Research: Issues of Definition?

When the term participatory research is used nowadays to describe an agricultural research activity, it may refer to any one of numerous diverse approaches ranging from an informal survey with a dozen individual farmers to rapid appraisal with thousands of small groups, to a process of group empowerment in a village, to formal experiments designed and conducted by farmers' co-operatives all over a country, just to give some examples. In order to really understand what is being described as "participatory", a number of issues need to be clarified by addressing questions like the following.

What type of participation is involved: are the participants involved in making decisions, or is their participation more of a consultative type in which their opinions are sought? What is the degree or strength of the participation of researchers and farmers: are researchers leading and inviting farmer input; or are farmers setting up the investigation and seeking researchers' contributions? What is the participation for, what is its objective: is it to help set priorities, for example, or is it to demonstrate solutions?

How is the participatory process managed: is it functional participation that has a useful result for the researchers but which is not designed to build any particular capacity in the farmers participating? Or is it designed to be primarily a learning and an empowerment process? At what stages of the research continuum are farmers involved: in pre-adaptive research when technologies are being designed; in adaptive research when basic design principles are fixed and farmers are making adjustments to fit special circumstances; or in validating technologies already proven in their locale? Who is participating: are the participants extensionists, researchers involved in preadaptive research, expert farmers, consumers, traders, or representatives of a special interest group, like poor women?

In whose "backyard" is the participation occurring: is this a research process in farmers' fields or home gardens, with an objective and "treatments" defined by the people who manage those spaces; or is this a research process on experimental plots defined by researchers, whether in farmers' fields or on experimental stations?

What are the criteria for successful participation: what makes it worthwhile, how do the participants evaluate the process and the results?

There is no a priori correct answer to these questions, but there are very different answers and there are different positions as to what is correct. Different answers imply different starting points, objectives, and criteria for success. Different starting points and criteria for success require very different approaches to assessing impact. In order to be able to say what is useful to research and what is useful to farmers, what works where and when, what is fashionable rhetoric, what is of scientific merit, and what is authentic empowerment, it is essential to be clear about the objectives and criteria for success that each different approach implies. The next section of the paper looks at these issues in more detail.

**Types of Participation**

The need to distinguish different types of farmer participation in agricultural research has been recognized in the literature for some time. Usually three or four types are identified: nominal participation (farmer lends land and labor to researchers); consultative (farmers' opinions are sought); action-oriented participation in which farmers are involved in implementing some steps of the research; decision-making participation in which the farmers have a role in deciding what is to be done and how to do it, as well as in carrying it out. Research also distinguishes a type called collegial participation in which researchers are involved in strengthening farmers' own research.

Decision-making participation can involve different levels. Farmers may have one representative on a planning body which includes representatives of several other interested parties to the research; and they may have one vote, or simply a veto. Or farmers may constitute the majority in a planning body, with researchers in a minority or in an observer and non-voting role.

It can also be important to identify whether farmers have any accountability for the results of the decisions they are participating in, and to whom are they accountable. Farmers may be involved in making decisions as a minority on a planning body over which they have no means of exercising accountability. In this instance, the objectives of farmer participation are more akin to consultation—getting farmers' insights and opinions into the decision-making process. Decision-making participation which has empowerment as an objective will be structured in order to link decisions with accountability for outcomes. The difference is important because the criteria for successful outcomes will be different. The impact of consultative participation—albeit in a decision-making forum—will depend on the quality of farmers' unique insights and objectives input into the decisions. The impact of empowering decision-making participation will depend on the capacity for reaching decisions which can be enforced, or for which there are effective sanctions for non-compliance in farmers hands. In terms of research, this may mean that farmers will have some control over the financial or other resources used for the research and will be involved in evaluating the performance of those carrying out the research.

*How Strong Should Farmer Participation Be at Different Stages of Research?*

In formal experimentation, there is a recognized hierarchy of levels of farmer participation: researchers lead the design and implementation and invite some farmer participation; researchers and farmers have unique contributions depending on their area of special expertise. This approach is more like a form of team-led research; farmers lead and invite some researcher input.

"Informal experimentation", which is more akin to what farmers do independently of any contact with research institutions, can be initiated and led by researchers, or it can be farmer-led with researchers involved as observers, or actively helping to monitor and analyze the results.

Clearly there is no formula for deciding which level of participation is "best." The level chosen will depend on the objectives of the activity, as well as the type of crop, livestock enterprise or technology the research involves. It is clearly important, however, to distinguish clearly which of these levels of participation we refer to when research is called "participatory."

*Farmer Participation in What Stages of Technology Development*

All knowledge generation, whether by scientists in formal research systems or by farmers using their own modes of empirical testing, involves an interactive, and usually nonlinear process which can be divided into the stages listed in Box 1. Typically, farmer participation has been in the stages of diagnosis, evaluation, and validation of technology in a consultative role. More adventurous applications of participatory methods have involved farmers in prioritizing solutions, and designing how to test them.

Seldom are farmers involved in evaluating the success or efficiency of a research program, which reflects on the issues of accountability raised in the introduction to this paper. Farmers participate, but the managers of the research they are participating in are seldom accountable to them; and the farmers themselves are not accountable for the success or efficiency of the program.

**Box 1. Farmer participation in what stages of technology development**

- Setting research priorities (which problem to work on).
- Diagnosis of problems (understanding cause and effect in a chosen problem area).
- Selecting and prioritizing which solutions or new ideas to test.
- Planning how to do the testing (e.g. what kind of experiment to do).
- Carrying out the testing.
- Evaluating the results and deciding which solution to recommend.
- Demonstrating recommendations or best practices, training farmers, disseminating information.
- Evaluating the success or impact of the research.

The stage of technology development in which participatory research takes place is fundamentally related to the question of how the division of labor between farmers and researchers is defined in the process of research and development. In part, this division of labor depends on the level of respect and legitimacy accorded to farmers' knowledge by researchers. But it also depends on the type of problem, constraints, or innovation which is being researched. For example, in participatory breeding, farmers' knowledge of quality characteristics, and of plant types for adaptation to specific production systems, is notably more specialized than that of researchers; whereas the scientific knowledge of pests and pathogens and biological control, or the genes which confer desired quality characteristics require a level of specialization beyond the empirical understanding that farmers can bring to the process. Identifying the appropriate division of labor between scientists and farmers in a research task is a critical first step in achieving efficient functional participation.

For this reason, this question of the stages of research that are undertaken, and the division of labor among researchers and farmers being practiced in a given stage, needs to be asked when we answer the question of what do we mean by participatory research in agriculture. A first step is to ask what the role of farmers can be in pre-adaptive research: this is a stage of technology development when problems are still being conceptualized in terms of the cause-effect relationships and prototype solutions are still being designed. A second step is to ask what is the role of farmers and researchers in adaptive research: this is the stage when a proven solution has to be tested for a specific location. A third step is to ask what is the appropriate division of labor in the extension or massification of a locally adapted solution to all other potential beneficiaries in a similar locale.

It is possible to understand more clearly the criteria for success and expected impact of a given type of participation, by first differentiating the level (i.e., whether this is in a farmer-led or researcher-led process), and by then distinguishing which stage(s) of technology development it involves, and the division of labor between farmers and scientists being realized within a given stage—specifically with respect to the responsibilities they take in the different activities usually involved in completing a research task (listed in Box 1). For example, farmer decision-making in planning a farmer-led process of farmer-to-farmer extension of known varieties has very different expected impact and criteria for judging its success from farmer decision making in planning a farmer-led process of pre-adaptive plant breeding in which farmers manage breeding populations. A farmer-led process of consulting other farmers about ways to test different IPM components is very different from a researcher-led process of consulting farmers about ways to test IPM components: the first type of participatory research has a strong element of building the capacity of farmers to do research, and success in building this capacity may be a criterion for judging the success and utility of the approach; the second does not.

## Who Participates: Gender and Other Variables

Two aspects of who participates in a research process need to be clarified in order to interpret the nature of the process. One is whether the participants are representative of a population or populations of end-users, and why representativity is relevant for the goals of the participatory process. The second is whether the participants bring relevant expertise to the process. In some participatory research, it may be necessary to satisfy both conditions: expertise and representativity. For example, research aims to develop technology for nomadic pastoralists and needs to include representatives of those practicing traditional as well as adaptive forms of pastoralism in order to design technology for both situations; in addition, knowledge of traditional livestock veterinary practices may be crucial to the research, so the involvement of pastoralists with this specialized knowledge is required. Functional participation may emphasize specialist participation to the detriment of the empowerment of the broadly represented population. A process which has empowerment as a primary goal may prioritize representative participation.

The issues of representativity and specialist knowledge are at the heart of the need to apply gender analysis as an integral part of any participatory process. Gender is a basic determinant of representativity, because men and women in agricultural societies fulfill such different roles and responsibilities; and gender therefore, often determines specialized domains of knowledge related to gender-differentiated functions—for example, saving seed as a women's function, which means that women often select the next generation of plants.

Gender is also cross-cut by wealth (or poverty): poor laboring women may have more in common with poor laboring men in terms of their criteria for technology design than poor and well-to-do women. Therefore, representativity and specialized expertise need to be used as criteria for distinguishing who participates, in the context of other variables like gender and wealth.

**Farmer Participation in Research to What End?**

The classification of different types and levels of participation, the research activities in which they take place, and the stage of technology development involved, need to be carefully placed in the context of the overall goals of the participatory research process being analyzed. These may be several: getting technology adopted by farmers (a goal of functional participation); building the capacity of farmers to make demands on the formal research system (relevant to both functional and empowering participation); strengthening farmers own research by providing inputs to it (can be relevant to both functional and empowering); conserving indigenous knowledge generation processes.

A hypothesis intended for further analysis in this meeting is the following: that these goals are not necessarily mutually exclusive, and can be mutually reinforcing, but exclusive emphasis on one can delay or damage progress in another. Thus a participatory research process that emphasises exclusively functional goals of getting farmers to test, validate and adopt researchers' best-bet technologies may weaken or delay the development of farmers' own research capacity. Achieving a balance among the three goals may be important for achieving rapid technical change and efficient research. Conversely, exclusive emphasis on capacity building may weaken or slow down the rate of technical change which might otherwise occur in a participatory research process. These are questions which require empirical assessment, because the answers will be important as guidelines for use of participatory approaches as part of normal science.

## How We Do Participatory Research

Means and ends, methods and goals are, of course, intimately related. How we do participatory research is fundamentally related to the end we have in mind. One way to do participatory research, which is highly popular and being rapidly taken up by development agencies, can be described as "have tool kit, will travel", commonly called PRA—participatory rapid appraisal. The early practitioners of this approach are now increasingly uneasy about its use to extract information from rural people for use by outsiders, without any capacity building or long-run commitment to action as a result of the PRA. Another way to do participatory research is to involve the participants in an analysis which leads to their better understanding of their situation and to a basis for joint action, if appropriate, with outsiders. The costs, time-frame and criteria for success of capacity-building approaches are not well systematized, nor have they been easily replicated or scaled up, unlike PRA. It is not clear whether this lack of ready replication and scaling up is inherent in the approach, or whether it reflects the need for more work to systematize these approaches. This is potentially one of the key challenges for the future, especially if it can be shown that the payoff to capacity-building approaches is significant.

A hypothesis for further analysis is that capacity-building approaches may have the highest payoff for technical innovation in agriculture in difficult environments (poor marginal populations, fragile ecosystems).

## What is the Payoff to Participatory Research in Agriculture?

In order to survive the trivialization and dilution of the concept, it is imperative that the question of payoff to using participatory approaches be addressed empirically, because evidence on this is still sadly lacking. If we accept that it may be useful to develop a form of classification or typology of approaches along the lines suggested above, the question remains: what are the advantages and disadvantages of different approaches? In what circumstances does a participatory approach have clear advantages over a non-participatory approach? Several questions on which evidence and guidelines need to be formulated are summarized in Box 2. To answer questions like these, unambiguous criteria for what constitutes success or impact and payoff must be defined.

There are several such criteria. One will clearly be the impact on technical change, both the number and diversity of technologies that are generated or transferred horizontally through participatory approaches, as well as the rate of adoption achieved. A second will be the effect of participation on the cost-effectiveness of research: is involving farmers merely an expensive gesture towards democracy; is it a highly efficient way of fine-tuning adaptive research; or is it a way of avoiding costly dead ends and white-elephant technologies no farmer wants to adopt in the pre-adaptive stage of research; or is it a cost-effective way of identifying imaginative new breakthroughs that combine different kinds of knowledge about a problem and its possible solutions?

| **Box 2. Need for evidence and guidelines** | |
|---|---|
| 1. | What degree of user participation is appropriate at a given stage in the R & D process? |
| 2. | What approaches to FPR/GA are most effective for different types of technology? e.g. knowledge or management intensive. |
| 3. | Are FPR/GA tools and techniques broadly applicable, or do some tools bias outcomes with respect to different kinds of impact? |
| 4. | How do we measure benefits and monitor performance in relation to different goals? |
| 5. | What are the costs? |

Other criteria might be related to the empowerment for farmers as an end in itself; or as a key element of a cost-effective research system. As farmers become empowered and their capacity to take on research functions increases, does research cost efficiency go up? Or do cost structures simply shift with the same net overall cost of the research process? Are there significant spill-overs to other sectors (such as health, child nutrition, schooling) from empowerment and capacity building in an agricultural research process ?

Another way to look at empowerment and capacity building through participatory research processes, is in terms of social capital formation, or building more effective ways of organizing and working together. If farmers and researchers involved in participatory research build social capital, does this lower the transaction costs of, for example, adaptive research and extension efforts?

Other aspects of payoff might be in improving the effectiveness of research in reaching the most needy, or other groups specifically intended to benefit from an agricultural research and technology development process. Do participatory approaches result in more accurate targeting of a technology design to meet the needs of a beneficiary group like poor rural women, for example? Targeting may not be more accurate than that achieved by other approaches, but it may be achieved more quickly and at lower cost.

The new frontiers of research in this field must be mapped by addressing some of the questions related to the critical issue of payoff if the potential of participatory approaches is to be realized.

# DO YOU KNOW THE PYTHON?
# MOVING FORWARD ON THE PARTICIPATORY RESEARCH METHODOLOGY DEVELOPMENT PATH

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## Introduction

In this paper I will reflect on the development of participatory research methodology through a brief analysis of the International Development Research Center's (IDRC) intellectual and financial support for participatory-oriented research projects. IDRC is a so-called crown corporation, a donor agency funded by the Canadian government, but with an independent, international board of governors. Last year the Center celebrated its 25th anniversary; the funding of participatory research projects dates back to the middle of the 1980s.

In the first part of the article, I will give an overview of the evolution of the Center's policy and programming concerning participatory research methodology highlighting a few issues of particular interest. In the second part, I will present some of the lessons learned about the use and impact of this methodology, combining my own ideas and experiences, reflections made by IDRC colleagues (published in a number of papers and reports), and critical thoughts provided by a number of outsiders (consultants to the Center). To illustrate some of the points that I am making here, a few currently IDRC funded projects will be presented in summary form.

## Empowerment Through Knowledge

"Empowerment through knowledge" in developing countries by developing countries' researchers (in the South by the South), is in a few words what the International Development Research Center is all about. Through financial and technical support to applied, development-oriented research projects, the aims of the Center are to provide the means to people to learn how to:

1) study their own situation, problems, constraints and potential;
2) gather and analyze relevant data concerning the above;
3) propose actions and execute plans and projects that will solve identified problems and improve the livelihoods of the people efficiently and effectively;
4) assess the outcomes of the research and intervention process, and to learn from these outcomes for the benefit of future projects and programs.

These objectives are very much in line with the general goals of participatory research which emerged, to put it simply, to make science respond more directly to the ideas and needs of people most affected by underdevelopment. It is important to state here that this does not only mean the development of (better) technologies (agricultural or other), a position that some seem to defend (e.g. Bentley, 1994: 142). Apart from new and improved technologies and increased capacity to do research, more functional forms of organizations or institutions and better policies are also seen as responses to the problems of underdevelopment. In other words, participatory research is seen as a process to better understand the complexities of social life and, as such, to provide a sounder base for action.

At the heart of this approach is a collective effort by professional researchers and non-professional researchers to; 1) set research priorities and identify key problems and issues; 2) to analyze the causes that underlie these problems and issues, and; 3) to take action to find both short and long-term solutions for the identified problems. It is expected that such an approach will have a positive impact on both effectivity (an increased use and acceptability of research results), and efficiency (making better use of resources/reduce costs of project execution and delivery of results). The above summarizes the reasons why the International Development Research Center, as a donor agency and partner in research, is interested in participatory research.

**Project example # 1: The Consortium for the Sustainable Development of the Andean Ecoregion (CONDESAN)**

In 1992, researchers from the International Potato Center (CIP) in Lima, Peru in co-operation with partners from national institutions in the Andean region, and assisted by IDRC program staff, created CONDESAN: the Consortium for the Sustainable Development of the Andean Ecoregion. CONDESAN aims to create a *community* of natural and social scientists, policy-makers, development specialists, NGO staff and farmers willing to improve the livelihoods of the rural poor and tackle the growing threat to the natural resource base of the Andean region (Rueda, Zandstra and Li Pun, 1994: 48-49; CONDESAN, 1996, 2).

Evolving from disciplinary and commodity-oriented approaches as well as farming systems research, the Consortium seeks to combine technical, institutional and policy research at several levels (farm, municipality, watershed, ecoregion) using democratic procedures, decentralized management and participatory research and development approaches. The consortium model is expected to generate synergies among partners and to achieve goals that institutions on their own would not be able to accomplish. Co-operation instead of competition is seen as a means to solve problems and make more efficient use of human and financial resources.

One important participatory technique used by CONDESAN partners is the *mesa de concertación*, a kind of round table that brings together municipal authorities, NGO staff, university personnel and farmers -- all seen as stakeholders in the sustainable management of the natural resource base -- to openly discuss problems, analyze conflicting or diverging interests at the local level and find agreements or solutions (which is the meaning of the Spanish verb *concertar*). The *mesas* serve both as a space and as a process to join forces and develop new initiatives with the use of locally available resources and, if required, outside expertise. In Ecuador, there also exists a *mesa* at the national level to convene CONDESAN, partners and jointly plan consortium activities. External evaluators of CONDESAN who recently completed a review of the Consortium (May-June 1996), were very enthusiastic about this innovative participatory technique used in Ecuador and Peru, both in terms of effectivity and as a new tool for the democratization process in Latin America (Mateo, Brown and Weber, 1996: 17-18).

## Review of IDRC Projects: Moving Forward

IDRC has reviewed and documented, either internally or through consultants, its support for participatory-research-oriented projects in 1987, 1988, 1989 and 1995. The publication of these reports in itself could be seen as a sign of the times: an increased interest in and reflection on the usefulness and limitations of participatory research methods by Center staff. From these reviews we can learn the following.

Within IDRC, support for participatory research originated in the Social Science Division. Staff in this Division saw participatory research as bringing ethnography one step further: incorporating local people actively into the research process itself. A similar change took place among colleagues in the Agriculture, Food and Nutrition Sciences Division. Here, staff aimed to bring farming systems research one step forward by looking at the interrelatedness of the physical, biotic and sociocultural aspects of rural life. They also wished to explore ways of blending farmers' and scientists' knowledge, recognizing that farmers do experiment with crop varieties, planting and harvesting techniques, and tools (see also Bentley, 1994: 141). In addition, staff acknowledged that scientists' knowledge and experiences are limited (IDRC Working Group, 1988: 8). This move toward more participatory research has gone hand in hand with more emphasis on interdisciplinary projects (Thompson, 1994: 6-9; Kapila and Moher, 1995). This evolution is reflected by the creation in 1995 of one single Programs Branch to replace the former disciplinary-based research divisions of the Center.

These changes were motivated by the reflections of IDRC program staff on Center-supported projects and also by changes taking place at a political and economic macrolevel, e.g. the emerging and growing critique of the Green revolution and its negative impact on the environment. There was a growing awareness that technology-oriented projects with agendas set by researchers, and experiments carried out on-station, were not having the expected impact (see for a general discussion, Chambers, 1993: 62-63).

In the Health Sciences Division, it turned out to be more difficult to support participatory research projects, which was explained by IDRC staff who pointed out that: 1) those who possess the power of healing in the health sector do not give up control so easily, 2) medicine is seen by most people as full of mysteries and thus as difficult to "tackle", and 3) it takes people a while to contribute a new meaning to health, i.e. to see health beyond diseases, services and facilities (Grisdale: 1989: 18).

In terms of classifying the types of participatory projects that IDRC has funded and continues to fund, most projects make use of a "mobilized participation" methodology, in which a strong role is played by non-local, professionally trained researchers.

Second: the opening page of the 1988 report describes participatory research as "a mode of research which is attracting growing attention from agencies of development assistance but which remains exploratory in many scientific domains". (IDRC Working Group, 1988: 1). This trend has continued, and what we now see is that participatory research is gaining ground in other institutions, including the World Bank and the Canadian International Development Agency (CIDA/ACDI). This is encouraging and hopefully will allow for interaction and exchange of experiences with IDRC-funded projects.

Third: the same 1995 report also concludes that "while participatory research has [now] become more widespread, considerable confusion abounds concerning terminology, types of participatory research, theoretical underpinnings, and operational practice". (Found, 1995: 70) The problem of confusion about concepts and operationalization was also identified in an earlier IDRC report (Grisdale, 1989: 12). Both the 1989 and 1995 reports have recommended the need to classify the types of participation being used or aimed for in projects, but given that in a six-year period not much improvement has been made, this seems to be a difficult issue to handle.

**Project Example # 2: Sustainable Hillside Agriculture in Colombia**

The Hillsides Program, co-ordinated by the International Center for Tropical Agriculture (CIAT) in Cali, Colombia, is an ambitious research and development endeavor aimed at improving the livelihood of poor hillside farmers in Latin America, together with the sustainability of the natural resource base. This is realized by developing sustainable land use and decision-support systems through community-based participatory research and development in a number of different research sites in Colombia, Honduras and Nicaragua (CIAT: 1993, 1995). The Program is innovative because it moves beyond "traditional" crops research on the one hand and farming systems research on the other. Its multistakeholder approach and focus on community organization give the program a clear action-oriented dimension (Ashby *et al.*, 1995).

The Program is carried out in a number of watersheds, along a continuum from more intensively exploited and longer-established settlement areas such as the Ovejas River in Colombia to a more recently deforested and newly settled hillside "frontier" such as the La Ceiba region on the Atlantic Coast of Honduras (Humphries, 1995). Two participatory research techniques used by the Hillsides team are of special interest: the so-called CIALs or Local Agricultural Research Committees (see Ashby *et al*, 1995) and the creation of the CIPASLA or Consortium for Sustainable Agriculture in Hillsides. The Program is identifying stakeholders within the watershed and bringing them together, through the CIPASLA consortium, to discuss and develop a common agenda for the sustainable management of the natural resource base, taking into account both intra-watershed and supra-watershed interests. CIPASLA is a unique interinstitutional alliance or consortium of 14 government and non-government organizations that promotes sustainable hillside agriculture. This is done through a planning-by-objectives process leading to a strategic plan, by the regular co-ordination of activities and the execution of a coherent set of projects (Munk Ravnborg, 1995: 121-130).

The idea of establishing CIPASLA first emerged at the end of 1992 when researchers, NGO workers and government officials all working in the northern part of the Cauca department came together for two days at CIAT to explore the feasibility of improving the co-ordination of their interventions in the area of natural resource management and community research and development. CIPASLA has currently financed 13 projects focused on reforestation with multiple use trees, organic fertilizers, biological disease control methods, the establishment of rural agro-industries, and the documentation of local values and culture concerning natural resources, among other things.

Developing on a parallel line with CONDESAN's *mesas redondas*, the keyword here is *concertación,* which means respecting each other and reaching agreements/consensus without losing one's own identity and comparative advantages. CIPASLA members strongly believe that through the sharing of ideas and resources they can move forward. "Concertación" also means that local communities match contributions made by institutions and by CIPASLA, financially, through labor, or otherwise. Giving away resources and services for free is no longer common practice. Magnolia Hurtado, the dynamic technical co-ordinator of CIPASLA, describes the building of trust and solidarity as a process of forging a new common CIPASLA-identity (personal communication, October 1995). She acknowledges that this is not an easy task for any of the participating organizations (NGOs, government agencies, CIAT). Conflicting or opposing agendas still exist, the duplication of efforts still occurs and, in general, organizations still operate in a supply-driven way. At the community level, farmers participating in projects funded by CIPASLA experience similar problems. As Don CJlimo from Pescador, one of the outstanding farmer-experimenters explains: "People are still very much enrolled in their own shell. Moving forward is not so much a question of money, but of mentality". (personal communication, October 1995)

Strengthening community ties means dealing with the problem of representation. An attempt is made to classify stakeholders in terms of their relative poverty and to analyze how these poverty profiles relate to the degree of participation in decision-making processes (e.g. within the CIALs or the watershed users association known as FEBESURCA). So far, critical monitoring of the organizational process has shown that there are clear differences in participation. For example, the farmers from the upper and middle altitude zones in the watershed tend to dominate the agenda setting of FEBESURCA at the expense of the lower-level farmers. Gender differences are also apparent. Women are clearly under-represented which points out the need to look at how the new organizational structures such as FEBESURCA and the CIALs put pressure on the available skills, time and other resources of women and men in different ways. We may assume that existing inequalities in resources and power influence the ways in which FEBESURCA and the CIALs are being organized, and the kind of activities that they carry out.

Fourth: reviewing more recent policy statements of IDRC that reflect new programming directions such as, for example, the Theme statements on Food Systems under Stress, and Biodiversity (see box), we can observe a strong emphasis on stakeholder involvement combined with an ecoregional focus. Increasing concerns about the (mis)management of the natural resource base stimulated the development of ecoregional approaches in which problems are addressed at a more aggregated level of analysis, e.g. a watershed. This approach allows people to deal more systematically with the interactions among components of an ecological system and the various productive activities carried out in a defined geographic area (e.g. farming, fishing, forestry). Stakeholder involvement refers to the active participation of small farmers, large farmers, entrepreneurs, municipal authorities, NGO staff and policy makers who together analyze problems and define research and development initiatives reconciling conflicting or diverging points of views and interests (Vernooy, 1993; Li Pun and Koala, 1994: 10).

In particular, the active involvement of "non-traditional" stakeholders such as NGO-s, municipal governments, grassroots groups and farmer associations is a new feature of IDRC projects. Currently, IDRC is supporting a number of large projects that use an ecoregional approach and that experiment with various forms of stakeholder participation in planning and decision making. We could mention CONDESAN and the Hillsides Program described in this article, as well as the East-African Highlands Initiative.

In other words, in methodological terms this approach implies a shift away from methodological individualism (Whatmore, 1994: 36) towards the analysis of geographic interdependencies and of social and political relations and tensions between multiple actors whose ideas, interests and identities constitute the actual practice of farming in a given agroecosystem. These relationships include the new and slowly emerging links between government and non-government agencies active in the field of agricultural development (Bebbington and Farrington, 1993: 199-219). It also means looking at farming as part of the wider agrofood chain that includes institutions that structure agricultural production, distribution and consumption.

In the closely related area of agricultural biodiversity, IDRC is supporting projects that aim to develop community conservation and utilization strategies (for example, the Community Biodiversity Development and Conservation Program, see Walter de Boef in this volume) as well as projects that use participatory plant breeding in combination with decentralized selection (see for example, Salvatore Cecarrelli in this volume). Both approaches aim to give the end users a more meaningful voice in the research and development process (Voss, 1996: 6-7).

*Food Systems under Stress Theme*

*The food systems under stress themes focuses on rural, indigenous and other groups vulnerable to food shortages living in critical ecoregions that are mostly marginalized in terms of socioeconomic development and ignored in terms of research and development efforts. Research is aimed at breaking the poverty cycle that forces many of the rural poor in these regions to mortgage the longer-term health of their environment and natural resource base to ensure their immediate needs for food. IDRC's approach is to support systems-based, interdisciplinary research in a limited number of ecologically fragile regions around the world, i.e. highlands/hillsides, arid and semi-arid areas and coastal zones. Emphasis will be given to the identification of viable household and community-based strategies and innovative institutional arrangements and policies. In terms of methodology, it builds upon the Center's leading role in the support of participatory research (IDRC - Food Systems under Stress Working Group, 1995: 1-2).*

*Biodiversity Theme*

*The world is facing habitat destruction at an unprecedented rate and on an enormous scale, which is creating an irreversible loss of biodiversity worldwide, but particularly in developing countries. This problem is compounded by the loss of knowledge of biodiversity and its use. IDRC's approach to the conservation and sustainable use of biodiversity is to build on the Center's strengths in supporting interdisciplinary research and its credibility to work with local groups. The overall objective is to ensure the availability and sustainable use of natural resources by local communities. The focus is on research that will identify the incentives and the institutions that are needed to encourage people to maintain biodiversity (IDRC - Biodiversity Working Group, 1995: 1).*

Fifth: although there is a growing awareness at IDRC about the need to fully integrate gender perspectives into programs and projects, in practice progress has been slow. As Waafas Ofosu-Amaah observed in her 1994 external review report on the gender diffusion process within IDRC (1994: 4), most of the projects that program staff consider to be gendered, are actually projects designed especially for women and do not necessarily deal with gender roles, perceptions and conflicts. This is confirmed by a more recent review of the degree of gender sensitivity of projects approved by the Center in 1995-1996 (Bromley, 1996), although it is fair to point out that there are a number of projects that appear to accept the importance of both women and men in the development process -from the conceptualization of problems and research projects, through the design, implementation, analysis and post-project evaluation process. Generally they also appear to recognize the various locations, roles and positions held by women and men within communities which provide and direct participation and interaction in the development project (Bromley, 1996: 10-11). Mainstreaming a gender approach within IDRC and in Center-funded projects is still a high priority.

**Project Example # 3: Food Systems under Stress in Africa**

The Food Systems under Stress in Africa project involves five interdisciplinary research teams from Uganda, Tanzania, Zambia, Botswana and Zimbabwe, and a number of resource persons from Canadian Universities and the School of Oriental and African Studies (SOAS), London, England. The network aims, through a process of participatory research, to involve local groups in food-focused action research at a variety of levels, from the household to the community to the national level (FSUS in Africa proposal, 1993; Pottier, 1995: 254).

The network brings together academic researchers, national policy makers, community workers, extension officers, district-level officers and a cross-section of rural people living in environmentally fragile areas to express and reflect on local perceptions of food stress and to develop activities to turn food insecurity into food security. The methodology used by the network so far consisted of, among other things, a series of focus group meetings and plenary sessions on food stress and household-level food security, seasonal calendars, gender-specific daily activity profiles, problem ranking, wealth ranking, Venn-diagrams, transect walks, and theater plays.

Experiences from the five countries so far are very diverse, but encouraging. The Ugandan team, working in the semi arid district of Soroti in the north-eastern zone of the country, obtained during their first participatory workshop a good insight into social differentiation based on unequal access to natural resources and labor, as well as an idea of different gender roles and the changing bargaining powers that women and men employ in getting access to food and money at the household level. The team also found out that, at the above-mentioned workshop, the poorest people in the area were absent. As Orone and Pottier reported (1995: 3), selection by the sub-county chief of participants had obviously left the poorest out. A similar problem occurred in Zambia where the so-called *nakalyas* or have-nots/most food insecure (as identified by the local people themselves) were under-represented (Sikana and Simpungwe, 1995: 93).

In Zimbabwe, during a similar participatory workshop, the project team discovered that a group of village chiefs had managed to steer a resource mapping exercise to include only certain villages with the clear expectation that these villages would receive (project) benefits (and others would not). The team was forced to sit down with the chiefs and address the question of "whose needs will be mapped?" (Mararike, Dzingirai and Pottier, 1995: 65) During the same workshop, the team also discovered that the local people were identifying the researchers as being very close to the government. As one of the farmers observed, instead of having to go through the long route of kraal head to ward councilor to district authority to ministry of agriculture, "the government was now next door". (ibid.: 65)

In Botswana and Tanzania, participatory techniques proved to be very powerful tools in bringing people from different backgrounds together to express their ideas and react to views formulated by others. In Botswana, these interactions also made government officials realize that food insecurity in the Kgalagadi district where the project is carried out, is closely linked to social problems such as alcoholism, divorce and teenage pregnancies (Lebohang, 1995: 123). As I had the chance to observe personally, it was truly an eye-opener for most if not all of the officials to become aware of these links.

## Lessons Learned: Key Factors in Success/failure

The review of past IDRC investments and experiences with participatory research and experiences of and reflections on ongoing projects such as CONDESAN, the Hillsides Program and the Food Systems under Stress in Africa network, allow us to identify a number of factors that appear key to the successes or failures of a participatory methodology. We could group these factors in two categories: factors concerning human resources and the building of partnerships, and factors concerning environmental, socioeconomic and political contexts. Without assigning priority, these factors are the following.

## Factors Concerning Human Resources and Human Resources Development

1. *The training of participants to become partners in a research and development initiative.* Important questions are: who needs to be trained, and in what? As the IDRC 1988 review report observes: "Rather the establishment of partnerships among groups of people (researchers and community members) to carry out novel tasks may often be an assiduous undertaking." (IDRC Working Group, 1988: 20). With regard to training, experience has shown that training should be followed up by networking, and that there is a need to allow

2. for time for the emergence of partnerships. This requires frequent face-to-face interaction and a medium- to long-term project time frame.

3. *The availability of sufficient time and labor*, and hence the dedication or commitment on the part of all stakeholders involved in the projects, is crucial for effective participatory research. This seems unfavorable to grassroots groups, farmer associations and NGOs who often lack money, time and human resources, although these are the organizations that most likely to use participatory research methodology (Grisdale, 1989: 16). This points out to the need to set aside funds and staff to support local level initiatives or accept the involvement of "outsiders".

4. *A shared common background by the (professional) researchers themselves*: this factor needs further validation, but it has been noted that wherever such a common academic or professional background exists, the participatory process will be more effective.

## Contextual Factors

4. *The fit of the project with local cultural circumstances, in terms of values but also institutional presence.* If farmers and researchers have different departure points, i.e. relatively well-off versus poor, urban versus rural based, access to outsiders versus isolated, and if these differences are unrecognized or not understood by the researchers, participation is more likely to be a failure. As a result, seemingly sound technologies developed by projects will not be adopted by farmers (Ayling, 1995: 106-107). There is a need for researchers to be on the same wavelength as local people. This implies that researchers need to challenge their own thinking and question their assumptions ("cultural baggage") and material (class) interests. This means that researchers need to situate themselves (Pottier, 1995: 257-258). This is also underlined by other researchers, e.g. Bentley (1994: 144) who points out that social distance between farmers and researchers is a major limitation on effective participatory research.

5. *Specificity of definition of who participates and how participation takes place:* the more ambiguously participation is defined, the more likely it is that the process will be ineffective (IDRC Working Group, 1988: 19).

6. Closely linked to the question of who participates is *the degree of heterogeneity that can be found at the local level and,* to make things more complicated, *at the regional level.* Here the question we need to ask ourselves, is how effective will stakeholder approaches be? "References to >village people= and >local communities= may well mask the realities of social heterogeneity which exist among project participants." (IDRC Working Group, 1988: 21) As the Hillsides Program research team has experienced, researchers need to be aware that the participatory research process is part of the construction of these

realities; and that, in most cases, this means that they will become enrolled in the "projects" and alliance making efforts of some individuals or groups (Pottier, 1995: 258).

7. *Environmental conditions:* the Hillsides Program, CONDESAN and the Food Systems under Stress in Africa network show that difficult environmental conditions do not seem to be a limiting factor. This seems to be confirmed by other IDRC-funded projects in fragile areas, but more case study analysis and comparison would be needed to strengthen this conclusion.

8. *Political context and political implications:* both context and outcomes can be favorable or negative.

9. *The scale of the project* does not seem to be a relevant factor, although this also needs further validation. So far, ambitious programs such CONDESAN and the Hillsides Program seem to have created the space for effective forms of participation. The Food Systems under Stress network demonstrates that participatory approaches also work at a more reduced scale.

## Concluding Remarks

As both the CONDESAN and the Hillsides Program demonstrate, participatory research for sustainable natural resource management is very much about the building and strengthening of local organizations. These organizations are the ways in which local people become empowered and empower themselves to have a greater say in decision making about the use and long-term management of soil, trees, water and animals. People perceive this clearly as a process of learning by doing which is usually advancing step by step. Planning by objectives which implies taking and giving, and building consensus while keeping one's identity, are key elements of these processes. The challenge is now to consolidate these new organizations and to strengthen their community roots and ties.

To conclude, I would like to reiterate that participatory research is, above all, about commitment, honesty and reflection. As one of the Zimbabwean farmers in one of the Food Systems under Stress in Africa project workshops questioned us: "Do you know the python? It comes unexpectedly and shows you its beautiful colors, then it disappears and you may never see it again. Researchers should not be like the python." (Mararike, Dzingirai and Pottier, 1995: 72). The same could be said for district-level policy makers, extension officers and donor agency representatives.

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# IMPLEMENTING FARMER PARTICIPATORY PLANT BREEDING: A RESEARCH MANAGEMENT PERSPECTIVE

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Modern agricultural research is organized, administered and managed according to a particular research paradigm. Based on empirical evidence and observations, hypotheses are formulated, then tested according to the rigorous rules of the scientific method. Standard conditions, replication and repeatability are fundamental to the process. The establishment of modern agricultural experiment stations during the 19th century allowed agricultural science to develop, and permitted its practitioners to apply the scientific method to the sloppy and variable natural world. The move from the site-specific, infinitely variable farmers' fields to a more uniform environment yielded more precise estimates of different treatment effects. This shift from a hit-or-miss to a more systematic approach yielded handsome returns. The tremendous productivity of modern agriculture and the success of modern plant breeding in particular, bear witness to the strengths of this approach.

Given the nature of the process, it should not be surprising that the greatest plant-breeding successes have been in rather uniform and "favorable" environments. Environmental uniformity allows the expression of superior performance over large areas under conditions similar to those found in experiment stations. Favorable environments provide a natural resource "buffer" to less-than-optimal crop management, in addition to allowing varieties to express their potential under improved management.

Despite its success in favorable environments, modern agricultural research, and plant breeding in particular, have had limited impact in less favorable environments. Farmer participation in plant breeding is proposed as a means of developing improved varieties adapted to harsher, heterogeneous and more variable environments. In its most extreme form, it is almost a complete reversal of the application of the scientific research paradigm to plant breeding. Experimental stations were designed precisely to avoid and eliminate the problem of conducting research on production farms. Agricultural scientists came into being because of the enormous commitment in time, education and experience required to execute successful strategic, applied, and adaptive research. We must examine with care the rationale for developing farmer participatory breeding (FPB) approaches and evaluate their effectiveness critically before discarding present practices.

It is essential to debate the question of whether the scientific approach is inadequate to meet the needs of resource-poor farmers living in difficult environments, or whether the scientific method has simply been improperly or inadequately applied to the more difficult environments. Unfortunately, this question is beyond the scope of this paper. For discussion purposes, I will assume that the rigors of scientific proof will still apply to the assessment of the performance of varieties developed under farmer participatory breeding; however, application of the scientific method may require drastic changes. Within this context, I will address some research management implications of adopting FPB.

## Characteristics of FPB

Although there is a bewildering array of FPB approaches, most share a number of features, and these have major research management implications. FPB tends to be decentralized to a rather large number of different sites, usually distant from research centers. Plot sizes are small, and even though upland fields are notoriously heterogeneous, space constraints typically limit replications to one per site. Management of fields is often left to the farmers; but, even researcher-managed fields receive less close scrutiny than experiment station fields, due to travel constraints. The distance from dispersed plots often limits the number of traits that can be evaluated, the frequency and precision of evaluation and the timeliness of the evaluations. In-season data collection and the harvesting of lines may be done by farmers alone, with the consequent implications for purity and accuracy. The environmental conditions during the growing season are usually monitored only at a very superficial level, if at all. Evaluations of materials may depend heavily on farmer perceptions, with cross-comparisons of farmer statements becoming a serious methodological challenge in culturally diverse target regions.

## Implications for Research Management

There are really two different management components to research that are impacted by adoption of FPB. *Research administration* is the institutional support mechanism to enable efficient and timely execution of research. *Research management* is the identification and prioritization of research issues, the identification and execution of appropriate research protocols, the evaluation and interpretation of research outputs, and the assessment of the impact of research, based upon the original priorities and upon which the research program was based.

Existing institutional research administration and management structures are designed to fit and facilitate the execution of the classical breeding paradigm. There are administrative units and procedures to execute the paradigm, there are budgets assigned to particular components, there is infrastructure, and there are the associated capital investments and maintenance costs associated with the paradigm. Perhaps most telling for the long-term future of FPB, there are careers associated with the existing breeding paradigm. There are careers that were made and nicely advanced within the old paradigm, and there are new careers pinned to the old paradigm. It is significant that senior administrators and managers probably reached their positions based on their perceived successes with the old system, and successful junior scientists are, in many cases, their protégés.

*Research Administration*

Current research budgets for plant breeding anticipate an experiment station-centered breeding program. Budgets for infrastructure construction and maintenance, seed stores, machinery, labor pools, agricultural chemical purchases, support laboratories and personnel, are typically structured to support large populations of segregating and advanced breeding lines. Costs for off-station work are typically limited to those for multilocation testing of very advanced breeding lines, often in satellite research stations. More extensive multilocation, on-farm testing is limited to very few lines, and is often under the responsibility of a different organization, such as extension services, NGOs, and farmers' associations. Thus, with current structures, the additional costs of on-farm research are administratively isolated from the costs of breeding per se.

Adding an FPB component to a breeding program poses a dilemma for research administrators. FPB will incur costs of a different nature from those incurred by current breeding. As it is highly unlikely, and in my opinion unwise, that an on-going breeding program will be dismantled and replaced with an untried FPB program, a research institution will incur net additional costs by adopting FPB. These will be costs associated with additional travel, agricultural chemicals, possible land leasing, additional vehicles, and additional labor, etc. In today's environment of ever-shrinking budgets, this money will have to be taken from within current budgets. Initiating a FPB program has the potential to cause internal conflicts and strife due to an increased competition for scarce resources.

*Research Management*

For the research manager, FPB can present some monumental headaches. We will assume that the difficult environments have already been given a suitably high priority to justify their own research effort. The research manager then must ask if plant breeding is among the most likely tools to impact on the targets? If so, is there sufficient evidence to suggest that the current paradigm, *if suitably adapted to the target environment*, will not yield satisfactory results? If there is reason to believe that a significant FPB activity should be initiated, which of the numerous approaches should be adopted, and how will success be evaluated?

There are well-understood outputs from classical breeding that a non-specialist can understand and weigh relatively objectively. Allocation of resources between classical breeding and FPB, especially at the outset, will be a major challenge - especially if no additional resources can be tapped.

Perhaps one of the most serious scientific problems that a research manager faces involves monitoring the research progress and the quality of the output. There are well developed scientific and statistical procedures to measure, monitor, evaluate etc. the old paradigm. However, FPB poses some serious problems. In the case of single replicates over a diverse environment, can real performance and improvements be reliably estimated? Statistically, how are major site-to-site and year-to-year differences handled? If the environmental conditions at the different sites are not carefully monitored, can performance differences be meaningfully compared? Without such comparisons, how can the FPB investment be evaluated, and is it yielding as much information as it can?

A varietal release program expects that its products will be of interest to a set of farmers several orders of magnitude greater than those who participated in varietal development. But, given the constraints of FPB, how do breeders interpret varietal performance beyond the conditions of the site of origin? Research managers will have precious little information upon which to base choices between which FPB programs, sites, targets etc. to support. If the beneficiaries of FPB are only to be the participating farmers, it is questionable whether there is even a role for the public sector.

In many FPB programs, farmers develop "varieties" based on bulk selection from fields. While this is suitable for the participating farmers, it is almost impossible to enter such materials into a formal varietal testing, evaluation and registration program. These almost always require a factual, documented, statement of parentage, and the selection program and performance of the original lines against a predetermined set of criteria. These requirements were developed over many decades to protect farmers and assure that the new varieties offered an improvement over existing materials. With no clear original material, varietal purity and integrity cannot be assured. Breeders were also protected in that their contributions were recognized and that their intellectual property, in some cases, was protected.

The greatest research difficulty will be encountered in attempting to manage the coexistence of the two paradigms. Trying to fit the new into the old will impose a huge stress on the system. In fact there may be such fundamental incompatibilities that it will be impossible. But what are we to do? Most people would agree here that there is an important, if not central, role for the foreseeable future of classical plant breeding. And that what is required is the addition of a participatory dimension. But, is this realistic?

The solution of convenience is to add a separate structure to accommodate the new. The danger is that this parallel structure then competes with the old, and all sorts of funny things can happen ... funds and other resources sufficient only for one (i.e. originally assigned to the old paradigm) are divided between the two, in-fighting becomes rampant, sabotage of research can occur etc. This solution of convenience was applied to farming systems research, and may have contributed to its demise ... that, plus, of course, the commandeering of a multidisciplinary approach by one or a few disciplines. In many cases, farming systems research programs that were set up parallel to or independently of, classical agronomic research programs died a slow, painful, and costly death. Or worse, they linger on as yet more appendages to already bloated and inefficient agricultural research bureaucracies.

Thomas Khun in his book "The Structure of Scientific Revolution" concluded that true breakthroughs are inspired by intuitive leaps, not by painstaking, incremental experimentation. Before the new paradigms (he's the one we have to blame for this much overused term!) overthrow the old, however, the flashes of brilliance are verified: the intuitive leaps are filled in *ex post* by painstaking, incremental experimentation. FPB may well be such a breakthrough in agricultural science. If so, a critical analysis of FPB is called for. The challenge of this system-wide initiative will be to generate clear data sets that will enable research managers to make informed decisions as to when FPB is appropriate, which types of approaches to use, and under which circumstances to use them.

# PARTICIPATORY RESEARCH METHODS FROM THE NGO VIEWPOINT

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## Introduction

NGOs working in communities, encounter many factors that can affect the approach they take in identifying and confronting, in a participatory manner, the needs and opportunities for the development of target groups. These factors can be favorable or unfavorable. The acknowledgement of both is of importance, as they will have an effect on the development of methodologies to be used at community, household and technician level. Ultimately, one of the objectives of our work as an NGO would be to help communities and individual farmers recognize their problems and participate in the search for solutions based on the use of their own resources. Our work should be developed in such a way that, long after we have left the community, people can continue to solve problems by themselves based on their analysis and the identification of opportunities.

## The Advantages and Opportunities of NGOs over other Entities

The main advantage for NGOs working at grass-root level is the empathy or bond that exists between them and the community. As in the case of Grupo Yanapai, this comes from years of being present in the community. The fact that a level of trust and confidence in the NGO has been developed facilitates communication with the community and, therefore, the use of participative methods to identify development needs.

NGOs have acquired an even more important role in development work and technical support in communities in the past years, because of the reduction of government extension services caused by the present tendency towards privatizing all services.

The NGO can serve as a link between the community and other institutions due to its direct contact with farmers. For years, governmental, educational and private institutes have done research within their own compounds, far removed from the real needs of farmers. Research institutes should reinforce their connections with NGOs and in this way reach farmers' needs in a more effective manner. They can develop research on existing traditional or non-traditional technology involving use of local resources.

Although much has been said on the efficiency of different local or non-local technologies, research is needed to prove whether or not these technologies can be used in existing community situations. This can be done by means of on-farm experimentation instead of on-station experimentation done under controlled conditions which produces results of little if no use to farmers. Technologies can later be validated by NGOs at community level and feedback on the results of this validation go well back to the research institutes, thus establishing a relationship between all three groups involved (research institutes, NGOs, and farmers).

**Development, Evaluation and Use of Certain Methods: Importance of Gender Analysis**

Methods used to create consciousness within the community should involve the participation of all members, of both genders and of all ages as everyone participates in the production process. Men and women prioritize problems in a different way, according to their role within the household and the community. They can complement each other when analyzing information about the production system. The NRM evaluation can help bring out this type of information.

In conversations with male and female farmers about the resources the community had and how they were managed, the use of diagrams to illustrate what they were talking about proved to be of great help.

Although each gender knows its role within the production system, this is in an implicit rather than an explicit manner. A diagram can help record and reflect this knowledge and provide a course for further reflection. It is like expressing an idea orally and in written form. When somthing is written down, a person can reflect on what he/she has written and put the ideas in a more orderly manner, which makes it clearer for both reader and writer.

NRM methodologies can be used for planning and monitoring research and development activities for both technicians and farmers. They help technicians to better understand how communities use their resources, and what lies behind the various practices that are followed and therefore, they improve their links and relationship with communities. On the other hand, with the use of these methodologies, communities have a better grasp on their own resources. They can plan future activities based on the information obtained and monitor changes occurring through time. The methodology can also be of use during the communal meetings in pointing out conflicts or problems to be tackled or in identifying weaknesses within the communal organization.

With regard to building capacities, NGOs can work not only with farmers but also with educational organizations, both at elementary and higherl levels. Unfortunately, because of the prevailing educational system, students do not have the opportunity to come in contact with the peasant community and their production systems, and therefore know little of the reality in the field. Education should be totally oriented towards the reality of each region so that it can be an "education for community service".

On the basic level, rural elementary schools could create an awareness on the importance of the rational use and preservation of local resources, and could develop knowledge and skills that will help pupils to live better and produce more efficiently in the future.

Grupo Yanapai has had the chance to work in natural resource management workshops where undergraduate students of different disciplines such as animal science, agronomy and anthropology have participated. These workshops were opportunities for them to exchange information and learn from the farmers, hopefully creating in them awareness about farmers' problems and the need to make a more efficient use of existing local resources.

Many students who participated in these workshops, are now willing to continue participating actively in follow-up activities and have even formed their own groups of resource management studies. What they need now is a continuation of these activities (maybe via practice periods with an NGO) so they do not lose their motivation.

In the Central Andean Valleys, Grupo Yanapai's work zone, working with communities is important, especially when it comes to natural resource management. Large amounts of the resources belong to the community and it is the community who decides how their resources are to be used, as in the case of water and land.

However, there are drawbacks: namely a weakness in the community organization and, lack of continuity. As a result of years of social turmoil, most community leaders have disappeared and therefore there is a weakness in the community organization. Usually, when a community leader changes, there is a ??? in the continuity of any work plan the former leader might have had. When it comes to decision making, the same thing happens. How can the community make compromises in order to participate in development or research activities when their leaders cannot? One example is the availability of water. To be able to diversify crops in a community, people need better access to water resources. This however, does not only depend on them but mostly on community leaders who must first find the means to finish the water channels and then organize a committee to control the equal use of water by the whole community. Without a strong organization and a sense of continuity, they cannot confront government authorities in order to negotiate their needs.

## Challenges and Dilemmas Ahead

Out of the many challenges that might exist, probably the more outstanding ones are:

1. How can we confront community organization weaknesses? They can represent an obstacle when it comes to development. In what way can we overcome them?

2. NGOs can have an active role in education in creating awareness in the younger generations on the importance of conservation and the rational use of their local resources, and in linking communities with students.

3. How can research be guided towards more realistic problems? Why are there still problems in associating NGOs with research? After all, they can be an excellent mediator in improving the flow of information between researchers and farmers.

4. The greatest dilemma for NGOs working in communities is:
   When working with resource-poor communities, how can you satisfy their everyday needs and at the same time work to preserve their ecology? What incentive is there for them? How can you convince them to work for the future when they have to eat today?

# METHODOLOGY DEVELOPMENT ISSUES FROM A NATIONAL RESEARCH PROGRAM PERSPECTIVE ZIMBABWE INITIATIVE

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## Participatory Research Methods and Development

A review and analysis of existing PR methods for their appropriateness in the cultural context of Zimbabwe has the objective of identifying or modifying and/or developing suitable, effective and acceptable PR methods for research and development in Zimbabwe. However, little is known of their cultural appropriateness, let alone their effectiveness in different cultures in Zimbabwe. The Department of Research and Specialist Services (DR & SS) in Zimbabwe is seeking ways of creating partnership with farmers in research and development.

## Gender Analysis Methods and Development

Women farmers in Zimbabwe by virtue of their numbers and their important role in food production, food security and natural resource management are a critical factor in rural development. Therefore, when attempting to develop appropriate crop production practices and help farmers understand and deal with their problems, it is necessary to develop techniques for identifying major constraints and to develop means of achieving an equitable balance of males and females i.e. gender analytical tools. Although women are the major actors in small-scale agriculture in Zimbabwe, particularly in the communal areas, PR methods have not emphasized the role of women as the crucial factor in rural development. DR & SS aims at developing appropriate gender analysis and research and development as a step toward improving the quality of life by trying to satisfy basic human needs, especially the needs of women farmers.

## Transfer of Technologies for Research and Farmers

The legacy of the colonial period still characterizes the practices of agricultural production systems in the communal areas of Zimbabwe today. Women's knowledge of plant production and protection have been effectively discouraged and relegated to one side and replaced by imported technologies for which women farmers do not have the appreciation, knowledge, education/training, technological capacity or resources to adopt completely. Moreover, most development programs have been run solely from a technical intervention basis, often using a top-down approach with inappropriate solutions for the problems at hand. DR & SS sees the need for more people-centered or demand-led programs and fewer technology-transfer models in which indigenous knowledge is used as a starting point for systematic agricultural research. There is, therefore, a need for the creation of a new cadre of development professionals who will develop programs that seek to develop and rigorously test new development approaches for appropriateness. Farmers also need to be trained in PR methods in which farmers, researchers and extensionists are partners in R&D instead of the top-down approach where they are only the passive recipients of technology transfer or production packages. The farmers' participation is viewed as a process of empowerment of rural people which will include farmer training for self-reliance, based on their own resources and production environment.

**Guidelines for the Integration of Gender Analysis into Research & Development**

About 70% of farmers in the communal areas of Zimbabwe are women, yet they have not been considered as producers in their own right in terms of the delivery of technology, farming methods and other information related to productive farming. The Government of Zimbabwe, extension services (both Agritex and non-governmental) and DR & SS are now showing an increased awareness of the need to change the manner in which development services are delivered, so as to take into consideration the specific needs of the various categories of farmers, particularly women farmers. Since 1992, Agritex has been engaged in gender agricultural extension in which gender issues within agricultural development have been designed to enhance better extension services to the majority of smallholder farmers in eight districts. DR & SS also sees the need for integration of GA into R&D, based on FAO guidelines for project design, implementation and evaluation. These guidelines call for the integration of women into research and projects based on the needs of women as perceived by themselves.

**Mapping of Natural Resource Endowments**

Small-scale farmers of Zimbabwe live and operate on marginal soils and have limited inputs. Low and erratic rainfall and poor soil fertility are the two major environmental constraints to agricultural productivity. These constraints are most acute in the semi-arid areas where the majority of communal areas are located, necessitating more exact management in agricultural production. DR & SS is seeking ways to maximize and stabilize production through PR, especially for women farmers who have the poorest resources. The areas should be under sustainable productivity using indigenous farming practices to avoid over-exploitation and serious degradation of the environment. The crucial point in developing technologies for these areas is to appreciate that economic and environmental sustainability are more closely linked to the evolution of systems than to revolutionary interventions. It is therefore, necessary that DR & SS researchers be equipped with the knowledge of the ecology in its totality and with social dimensions such as the recognition of indigenous societies and their environmental knowledge and technological capabilities.

## Modules and Materials for Training

Zimbabwe's initiative on participatory research and gender analysis demands the re-orientation training of farmers, researchers and extension workers in dealing with environmental constraints and socioeconomic problems faced by small-scale farmers, particularly women farmers in the communal areas. Since most of the physical and biological constraints have been caused mainly by the transfer of inappropriate technologies and the concomitant loss of indigenous practices for sustainable farming, it is necessary to train researchers and other development scientists in the values of both indigenous knowledge and bottom-up approaches. Other modules needed for training include: gender issues in research (roles of men and women), gender planning (roles in project cycles), strengthening women's involvement in agricultural development (women's needs in PR, for training, etc.) and capacity building in PR (importance of linkages with farmers). In order to reverse dependency syndromes created by top-down approaches, it is necessary to train farmers in the processes of goal and priority setting, and identifying their own constraints; methods for monitoring and evaluation; mechanisms for women to control projects (especially outputs); and technology generation. DR & SS plans to work closely with Agritex in developing modules and materials for training scientists and farmers in appropriate PR and GA as part of the capacity building of the department.

## Monitoring and Evaluation

There is a lack of methodologies for assessing many of the aspects of women and development such as the social and economic contributions that take up the major proportion of the time and energy of women. This calls for gender sensitization of all levels of research and development programs. It is therefore, imperative to involve women in the planning, implementation and evaluation of research and development projects. Women, as the main actors in agricultural production, are better placed to monitor projects on a daily/most frequent basis than extensionists and researchers. Women, with their vast store of indigenous knowledge, are also best placed to evaluate the comparable advantages/disadvantages of a new innovation over existing technologies, particularly as it relates to the farmer's inputs and production environment. Therefore, evaluation and impact assessment criteria should include women's own priorities and values as specified by them. DR & SS is working on a national strategic plan for research in Zimbabwe with an emphasis in small-scale farming on marginal areas and this needs a strong element of GA.

## Research, Extension and Farmer Partnerships

The majority of rural farmers are women, while research and extension staff are mostly men whose own training and cultural disposition do not lend themselves to full appreciation of women's plant production problems as specialist areas, such as postharvest technologies and women's crops. For example, an in-house assessment by DR & SS of the contribution of agricultural research to the development of traditional or pre-colonial crops has revealed the so-called women's crops such as rice, sweet potatoes, cowpeas, pumpkins and melons were the least researched. This suggests that women's knowledge and experience have been seriously undermined through neglect by both research and extension. This calls for development institutions to recognize farmers' knowledge, experiences and aspirations since this knowledge is an important basis from which to understand how a farmer perceives his/her environment especially in relation to food security. Therefore, the overall approach of research and extension should be both participatory and diagnostic for the scientists to discover the indigenous technology systems and understand their rationale. DR & SS proposes to work closely with Agritex, Zimbabwe Farmers Union, NGOs, and other players in gender planning and providing strategies for strengthening women's involvement in agricultural development.

## Gender Sensitizing

In spite of the major role played by women in agriculture in Zimbabwe and other developing countries, the importance of gender roles in agricultural development was not realized for a long time. Whatever the reasons for this discrepancy, there is now a need for gender awareness which requires a rational approach based on knowledge and a deliberate effort that acknowledges the role and experience of women. The process of creating awareness demands a great deal of sensitization at every possible level. Since women are the ones who perform most of the agricultural activities, it is appropriate for DR & SS to consider gender awareness planning in order to ensure that women's needs and opportunities are incorporated into PR and extension activities for sustainable agricultural production.

## Capacity Building

Most of the research, which has been conducted by DR & SS and other research organizations in the communal areas of Zimbabwe, has been based on single discipline-technology-transfer using a top-down approach. The impact of these efforts on target groups has been minimal, often because the technology did not address the priorities of the resource-poor farmers, at least within the socioeconomic setting. This scenario indicates that explicit attention should be paid to technology development and transfer and capacity building. In the harsh environment of the communal areas, farmers usually face a variety of constraints to agricultural production, and this calls for multidisciplinary approaches in developing strategies for sustainable agricultural production. Technology generation and transfer requiring training of farmers should be complemented by the appropriate training of research and extension staff. DR & SS envisage partnerships with IARCs, donor agencies, extension and farmers as the best way for strengthening its research capacity. Since farmers are continually involved in informal research processes, these partnerships must also help in identifying constraints in designing, implementing and evaluating development projects. However, in order to avoid the top-down approach and/or dependency syndrome, these linkages should ensure that farmers' participation would lead to the empowering of the rural poor for self-reliance in order to achieve their goals within their environment and use their practices.

## NARS - CG Partnerships

In the past, most IARCs have dealt principally with the core of the NARS. i.e. publicly funded institutes, mostly on the subject of increases in agricultural productivity. The CGIAR 1996 research agenda now calls for new partnerships at both national and regional levels with IARCs, TAC and with CGIAR as a whole. It also calls for national-level partnerships to be built with universities, private researchers, NGOs and the farmers. This indicates CGIAR's desire to be more involved at grassroots level with the NARS. Like other NARS, DR & SS is being called upon to do more and more with less resources. The Department has been actively seeking partnerships with the IARCs to complement its efforts in PR. At present, some of the most successful PR projects in Zimbabwe involving DR & SS and IARCs are agroforestry work on multipurpose trees with ICRAF, and work on sorghum and millets in dry areas with ICRISAT, both projects being most active in the communal areas. DR & SS would want more partnerships with the IARCs, as such linkages enhance the Deparment's efforts in PR.

| | **SW0 1** PR Methods PPB | **SWO 2** GA Methods NR | **SWO 3** TOT Training | **SWO 4** GA Guidelines | **SWO 5** Mapping |
|---|---|---|---|---|---|
| **ZimO 1** PR methods and Development | X | | | | |
| **ZimO 2** GA methods and Development | | X | | X | |
| **ZimO 3** TOT for Researchers and Farmers | | | X | | |
| **ZimO 4** Guidelines for Integration of GA into R&D | | | | X | |
| **ZimO 5** Mapping of NR Endowments | | | | | X |
| **ZimO 6** Modules and Materials for Training | X | X | X | X | X |
| **ZimO 7** Monitoring and Evaluation Systems | X | X | X | | X |
| **ZimO 8** Research, Extension, Farmer Partnerships | X | X | | | X |
| **ZimO 9** Gender Sensitizing | | | | | |
| **ZimO 10** Capacity Building | | | X | | |
| **ZimO 11** NARSs CG Center Partnerships | X | X | X | X | |
| **ZimO 12** Resource Pool of Trainers | | | X | | |

ZimO = Zimbabwe Output
SWO = Systemwide Output

# DOCTORS, LAWYERS AND CITIZENS: FARMER PARTICIPATION AND RESEARCH ON NATURAL RESOURCES MANAGEMENT

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## Challenge and Response

The challenge to agriculture -- and agricultural research -- has never been greater. As the agricultural frontier in developing countries disappears, there is an increased need to produce more food from less land; to maintain greater stability in agricultural production from less predictable growing conditions;and at the same time to help fight poverty, conserve agricultural resources and protect the environment. Research, in concert with other stakeholders in civilsociety, must help develop technologies, resource management strategies,policies and institutional arrangements that help attain commonly sharedproductivity - sustainability goals. Effective research on natural resource management (NRM) will be critical. NRM research that is effective produces useful results, influences large areas, and benefits a large populace -- in a reasonable time span.

One response to these challenges lies in better integration of farmers and farm families in the research process. There is an emerging consensus thateffective farmer participation in research on NRM -- and in many instances farmermanagement of such research -- is critical to its success (Bunch and Lopez 1995; Biggs 1989; Chambers and Ghildyal 1985; Collion *et al.* 1992; Lightfoot and Noble 1992; etc.). The effectiveness of NRM research is further enhanced whenparticipation extends to all relevant individuals within farm families -- including women. Another part of the response, then, is increased and more systematic use of gender analysis (Feldstein and Jiggins 1994).

Research managers, however, often find it difficult to marshal and organize NRM research resources to effectively address sustainability problems. In general, the capacity to understand and solve such problems requires a wide range of research skills, and further requires that these skills be coherently organized and integrated. Addressing sustainability issues through NRM research is like putting together a puzzle with many pieces. The whole picture is most clearly seen when the pieces fit together.

This paper argues that farmer participation and gender analysis (FPGA) are two critical pieces of the NRM research puzzle -- but that other pieces are also important. The paper goes on to suggest that success in NRM research may depend on the proper use of FPGA methods -- but that success also depends on a suitable integration of these methods into a broader framework. That is, success is likely to depend on a sensible matching of methods -- FPGA among them -- to the research functions that need to be served.

First, however, the paper compares two views of FPGA: as a means to an end -- more productive and sustainable agroecosystems -- and as an end in itself. After a brief review of the current abundance of FPGA methods, and a discussion of the matching question raised above, the paper concludes with a discussion of important issues that must be resolved if NRM research is to be truly effective -- and potential contributions of FPGA in resolving them.

## Doctors, Lawyers and Citizens

There seems to be little doubt that farmer participation and gender analysis (FPGA) can improve the effectiveness of research on NRM. FPGA can help researchers better understand and solve problems of resource degradation or stagnating productivity in agroecosystems; help find opportunities for sustainable intensification or diversification of those systems; and foster wiser use of land, water and biodiversity resources. In this way it can be seen as a means to an end -- more productive and sustainable agroecosystems, and a better environment.

In other ways, however FPGA can be seen as an end in itself. By facilitating the empowerment of communities to define and address their own problems, a decentralized process can be generated whereby rural peoples take increased responsibility for their own progress and development. At times, this may embrace the introduction of more productive and sustainable agroecosystems, and the wiser management of resources.

The above distinction is illustrated by comparing caricatures of two points of view. Some practitioners of FPGA see it as a means to an end -- these are referred to as doctors. Other practitioners see FPGA as an end in itself -- these are referred to as lawyers. No disrespect is intended to doctors and lawyers in the broader sense.

In this comparison, doctors are disciplinary scientists conducting research on sustainability - productivity problems in agroecosystems. Doctors tend to rely heavily on their own skills in diagnosis and in the prescription of interventions. At their worst, doctors can become mired in endless diagnostic tests, heedless of the ravages of disease (resource degradation, stagnating productivity). Or they may become mad scientists, dabbling with their patients' systems and prescribing the latest interventions (new technology) in order to see what happens, regardless of possible side effects on their clients' health (unintended longer-term or off-site consequences).

For the most part, however, doctors in agricultural research are caring professionals who are deeply concerned with maintaining (agroecosystem) health over the long term. Some of them are skilled specialists, conducting strategic research to find better ways to understand, diagnose and cure illness (resource degradation), or foster _wellness_ (sustainable improvements in productivity). Others are general practitioners, who involve their patients (through participatory research) in designing and assessing solutions to important problems. For the most, doctors see participatory research as a useful tool -- but only one among many.

Continuing the comparison, lawyers are individuals dedicated to fostering the empowerment of rural communities to define and address their own problems. Community problems may or may not be related to the productivity and sustainability of agroecosystems or the conservation of resources. Lawyers see participatory research as the hallmark of a healthy development process, an end in itself. At their worst, lawyers can be scientific Luddites, rejecting the notion that doctors can be of any use in working with farmers to understand and address productivity and sustainability problems in agroecosystems. Or they may be ambulance-chasers, looking for opportunities to cash in on doctors' (real or perceived) deficiencies and malpractice. For the most part, however, lawyers are dedicated individuals who help foster processes whereby communities can learn to understand and solve their own problems. That is, they are also teachers.

Doctors and lawyers are at their best when they also are citizens. A worthy citizen is concerned about the common good, the achievement of broad social goals and objectives. There is a place for doctors as well as lawyers in FPGA, especially in their common role as citizens. This, each of us can ask ourselves -- with respect to FPGA, am I a doctor or a lawyer -- and am I also a good citizen, acknowledging the appropriate place of my fellow professionals in helping solve the problems of civic society?

## A Richness of Alternatives[2]

There has been substantial recent progress in developing specific methods and techniques for FPGA. At present, scarcity of such methods does not seem to be the problem; indeed, there is a richness of alternatives. Here is a brief (and incomplete) summary of available methods and tools for FPGA. Note the very considerable overlap among the categories and methods, and the need for a gender lens as each method is applied.

*Interview Techniques:* semi-structured surveys, key informant interviews, the use of focus groups, individual interviews (e.g., Beebe 1985, Byerlee and Collinson 1980).

*Assessment of Local Knowledge Systems:* folk taxonomies, farmer classification of land types, traditional systems of organization, oral histories, status distinctions, decision point analysis (e.g., Warren and Cashman 1988, Tamang 1993, Harrington *et al.* 1993).

2 This section was inspired by on-going work of Harold MacArthur.

*Community Exploration Techniques:* community appraisals, group treks, participatory workshops, rapid site description, transects, biophysical assessments, indigenous indicators (e.g. Chambers and Ghildyal 1985, Conway *et al.* 1987, Chand and Gibbon 1989).

*Mapping Techniques:* sketches, historical patterns, agroecosystem zoning, (e.g., Scherr *et al.* 1995, Chambers 1990).

*Diagramming Techniques:* resource flow diagrams, seasonal diagrams, decision trees, problem-cause diagrams (e.g., Lightfoot *et al.* 1989, Gladwin 1995, Harrington *et al.* 1992).

*Time Flow Analysis:* seasonal calendars, time lines, time allocation studies (e.g., Maxwell 1984, Triomphe 1995).

*Setting Research Priorities:* triage, planning of experiments (e.g., Trebuil 1992, Collion *et al.* 1992).

*Farmer Experimentation:* farmers' adaptations, farmer managed experiments, farmer selection from among multiple alternatives (e.g., Ashby 1987, Fujisaka and Garrity 1988, Lightfoot and Noble 1992, Quiros *et al.* 1991, etc.).

Given this abundance of FPGA methods, it_s conceivable that the principal challenge for researchers does not lie in the development of new methods (although there is still room for progress in this arena). Possibly, the major challenge for researchers lies in more consistent and systematic use of these methods when they are warranted by the work at hand. Such decisions need to be guided by a framework that describes the functions of agricultural research as it contributes to the achievement of productivity - sustainability goals. That is, success in NRM research may depend on the suitable integration of FPGA methods into a broader framework -- the _matching_ of methods to functions. In the next section, one such framework is described, and roles for FPGA methods -- and for non-FPGA alternatives -- are discussed.

## Pieces of a Puzzle[3]

This section summarizes current thinking at CIMMYT on a framework for dealing with sustainability issues in maize and wheat systems. It is a problem-solving framework, wherein problems are understood to include resource degradation processes, as well as untapped opportunities to sustainably diversify or otherwise improve the productivity of these systems in ways that protect the environment. Rather than attack individual problems in isolation, the framework emphasizes interactions among problems and opportunities in defined environments.

Underpinning this framework is the notion that certain functions must be performed -- certain questions must be answered -- if research (not restricted to FPGA) is to help understand and

[3] Much of the material in this section is drawn from Harrington 1996.

address sustainability concerns. Nowhere in the framework is it suggested that CIMMYT -- or any other institution – is capable of taking the lead in all phases of research. Like most other institutions, CIMMYT does not contain within itself the full range of required skills.

As described below, the framework is comprised of research phases, with each phase corresponding to a different set of functions. Phases should not be interpreted as being linear. Movement to any particular phase is not conditional on success in previous phases. Rather, each phase receives a variable level of attention over time, according to the evolving understanding of sustainability problems and how to address them. In the following paragraphs, the different phases are described, and possible contributions from research -- FPGA as well as other research methods -- are discussed.

*Understanding and Defining Problems – Biophysical Processes*

Specific (and often quite complex) biological, physical and chemical processes underlie most resource degradation problems. Understanding these processes can be essential to designing new prototype solutions.
FPGA -- Indigenous technical knowledge (often incomplete).
Non-FPGA -- Strategic disciplinary research on biophysical processes; process modeling.

*Understanding and Defining Problems – Consequences and their Pace of Change*

Problems may have different consequences -- on-site or off-site, near-term or longer-term, economic or environmental. Problems also may affect some community groups (e.g., women) more than others (Tisch 1994). The consequences of a problem may unfold rapidly or slowly. An understanding of consequences and the pace at which they evolve is critical to setting research priorities.
FPGA -- Indigenous indicators of changes in resource quality or agroecosystem health, retrospective community information, time flow analysis.
Non-FPGA -- Quantitative indicators of change, modeling, long-term trials, farmer monitoring.

*Understanding and Defining Problems -- Incidence*

Understanding the incidence of problems is essential to assessing their relative importance and to targeting research to relevant areas. Incidence may be assessed in terms of farm-level niches (Chambers 1990) or may be mapped out at broader (watershed, regional) levels.
FPGA -- Community resource mapping.
Non-FPGA -- Database development, GIS.

*Understanding and Defining Problems – Causes*

Problems of resource degradation or stagnating productivity are normally associated with particular farmers-practices. Well-focused diagnostic research normally can uncover a chain of causes and effects whereby particular farming system interactions, or specific policies and institutional arrangements, are identified as causal factors for the problems of concern.
FPGA -- many of the diagnostic methods described above.
Non-FPGA -- policy analysis.

*Expanding and Understanding the Array of Options*

Problems whose processes, consequences, pace of change, incidence and causes are understood may be said to be well-defined. However, practical researchers are always concerned with finding suitable solutions to important problems, whether these are well-defined or not. Part of the process of finding suitable solutions lies in expanding the range of options, and the menu of potential technical prototypes. Prototypes may take the form of improved germplasm, better crop management practices, improved land management practices within farms, or changes in regional land use patterns. Policy or institutional changes may be required for them to be feasible.
FPGA -- farmer-developed practices; community-developed adaptations to community resource degradation.
Non-FPGA -- technical prototypes developed by research or known from the technical literature.

*Tailoring Prototypes to Farming Systems*

A prototype is a technology that still retains a considerable degree of plasticity. To be useful in the context of a defined production environment or farming system, the prototype must be adapted -- tailored, changed, reshaped and adjusted to fit local farmers' circumstances.
FPGA -- participatory adaptive experimentation.
Non-FPGA -- researcher-managed on-farm adaptive experimentation (often ineffective).

*Understanding and Accelerating Adoption*

It is not enough to have a well-defined problem and a range of prototype solutions being adapted to particular circumstances by farmer groups. Researchers must also understand the factors that govern adoption (or lack of adoption, or even disadoption) in order to: identify potential extrapolation areas for different technologies (to identify conditions favorable for participatory adaptive research, and findingout where these conditions prevail); and to identify opportunities to accelerate adoption through changes in policy formation, policy implementation or institutional arrangements.
FPGA -- local knowledge on factors governing adoption, and how practices are matched to ecological niches; initiatives in collective action.

Non-FPGA -- formal adoption studies, including economic analysis; policy workshops to foster policy change.

*Scaling Up*

Any research approach that seriously aims to meet the challenge of fostering sustainability and productivity in agriculture cannot be content with small-scale ventures in a couple of sites. The impacts of research must be commensurate with the challenges being faced. For research on sustainable systems to be truly worthwhile, the difficulties associated with scaling up must be confronted and overcome. These difficulties include questions of how to: combine and synthesize research results across sites within defined production regions; extrapolate technologies to larger areas where farmers may find them attractive; and understand links and interactions among levels of system hierarchy (e.g., plot, field, watershed, region).
FPGA -- (uncertain).
Non-FPGA -- modeling, GIS, decision-support systems.

*Understanding the Consequences of Change*

No research program is complete unless it features an integrated process of monitoring and evaluation. In the case of research on sustainable systems, evaluation is extraordinarily challenging because of the multitude of possible consequences of technical change. These include changes in near-term and longer-term on-site agroecosystem productivity; longer-term on-site quality of soil and water resources; changes in the ecology and biodiversity in agroecosystems; family and community health associated with input use; equity and income distribution within households, e.g., between women and men; off-site economic, ecological and environmental consequences; etc.
FPGA -- Indigenous indicators of changes in resource quality or agroecosystem health, time flow analysis and forecasting.
Non-FPGA -- Quantitative indicators of change, systems modeling, long-term trials, farmer monitoring.

## Making NRM Research Effective

In the above sections, it has been argued that NRM research can be made more effective by more thoroughly incorporating FPGA methods. Researchers need to

- take fuller advantage of the rich array of FPGA alternatives;
- more consciously match FPGA methods to research functions;
- integrate FPGA methods into a broader research and development framework;
- foster collaboration among FPGA experts and the broader research and development community (including collaboration between doctors and lawyers);
- improve quality control in the application of FPGA methods;

- more systematically apply a gender lens;
- pay more attention to the mainstreaming of known FPGA methods, while
- continuing to develop new ones.

However, if NRM is to be truly effective -- if it truly is to develop a capacity to handle important productivity - sustainability challenges -- then progress needs to be made in two specific areas. It is not clear if FPGA will have a leading role in either one.

First, NRM research must become much better at understanding and dealing with external consequences of problems (or of technical change), and impacts on the environment and on future generations. Why should we expect FPGA to help us understand siltation of dams used in hydroelectric power generation? Changes in soil microbiological diversity? Indirect market-led consequences of technical change on employment? Trends in food security in the decades to come?

Second, and most important, NRM research must become much better at scaling up. It must become better at combining and synthesizing research results across sites within defined production regions; at extrapolating technologies to larger areas where farmers may find them attractive; and at understanding links and interactions among levels of system hierarchy. Any research approach that seriously aims to meet the challenge of fostering sustainability and productivity in agriculture cannot be content with small-scale ventures in a couple of sites. If research on NRM is truly site-specific as many claim – if no principles can be extracted -- then the notion of effective NRM research may be no more than a fantasy.

## Conclusion

The challenge to agriculture -- and agricultural research -- has never been greater. Research, in concert with other stakeholders in civil society, must help develop technologies, resource management strategies, policies and institutional arrangements that help attain commonly shared productivity - sustainability goals. Effective research on natural resource management will be critical if we are to achieve these goals. How, then, do we make NRM research more effective?

One way is to better integrate farmers and farm families into the research process. Researchers need to take fuller advantage of the rich array of farmer participatory research/ gender analysis (FPGA) methods. They need to mainstream them more systematically into on-going work.

Another way is to better integrate FPGA methods into a broader research and development framework and, in the process, foster a better match between FPGA methods and the research functions they are intended to serve. Researchers need to develop a capacity to judge when a particular FPGA method is more suitable to the task at hand than a non-FPGA method -- and vice-versa.

A third way is to improve the capacity of NRM research to scale up -- to synthesize research results across sites and to foster the extrapolation of technical prototypes -- including new productivity-enhancing resource-conserving practices -- to suitable areas. If NRM research is truly site-specific, it may be condemned to irrelevance. FPGA methods may prove to be of little help here.

Farmer participation in research can be seen (correctly) as an end in itself. It also can be seen (equally correctly) as a means to an end -- more productive and sustainable agroecosystems, and improved food security for the poor. Clearly, this paper was written from the point of view of the doctors, not the lawyers -- by a doctor who also wishes to be a good citizen.

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# DECENTRALIZED, PARTICIPATORY PLANT BREEDING: A LINK BETWEEN FORMAL PLANT BREEDING AND SMALL FARMERS

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**Summary**

Participatory plant breeding is discussed not only for its advantages in exploiting specific adaptation, and hence in fitting crops to the environment, but also as the only possible type of breeding possible for crops grown in unfavorable conditions and/or remote regions, and in areas not sufficiently large to justify the interest of large breeding programs.

The paper describes the evolution of a typically centralized international breeding program towards non-participatory decentralization, and eventually to a decentralized and participatory approach. A number of methodological issues — such as the choice of participating farmers, number of lines to use, and the comparison between decentralization and participation — are discussed while illustrating a project on participatory barley breeding in Syria which began in 1996.

Participatory plant breeding — i.e. farmers' participation in selection of early segregating populations — should become a permanent feature of formal breeding programs. It should be linked both with the formal breeding system which can provide a continuous flow of novel genetic variability, and with the informal seed supply system which can spread new varieties in the farmers' communities without the unnecessary requirements of the formal seed system.

## Introduction

Formal plant breeding has been beneficial to farmers who either enjoy favorable environments, or could profitably modify their environment to suit new cultivars. It has not been so beneficial to those farmers (the poorest) who cannot afford to modify their environment through the application of additional inputs (Byerlee and Husain, 1993). Poor farmers in marginal environments continue to suffer from chronically low yields, crop failures and, in the worst situations, malnutrition and famine. Because of past successes, conventional plant breeders have tried to solve the problems of poor farmers living in unfavorable environments by simply extending the same methodologies and philosophies applied earlier to favorable, high-potential environments. Moreover, farmers in favorable environments who use high quantities of inputs are now concerned about the adverse environmental effects and the loss of genetic diversity.

The essential concepts of conventional or classical plant breeding can be summarized as follows:

1. Selection is highly centralized and is conducted under the high-yielding conditions of experimental stations;
2. Cultivars must be uniform (e.g. in self-pollinated species they must be pure lines), and must be widely adapted over large geographical areas; this is achieved by selecting for average performance in multi-location testing;
3. Locally adapted landraces must be replaced because they are low yielding and disease susceptible;
4. Disseminating the seed of improved cultivars must take place through mechanisms and institutions such as variety release committees, seed certification schemes and governmental seed production organizations. The requirements of these mechanisms and institutions are so strict that one wonders whether breeders are more concerned about the requirements of the formal seed systems than those of the farmers;
5. The end users of new varieties are not involved in selection and testing; they are only involved at the end of the consolidated routine (breeding, researcher-managed trials, verification trials), to verify whether the choices made for them by others are appropriate or not.

In situations where the objectives are to improve yield and yield stability for poor farmers in difficult environments, plant breeding programs rarely question the efficacy of this conventional approach. The implicit assumption is that what has worked well in favorable conditions must also be appropriate to unfavorable conditions, and very little attention has been given to developing new breeding strategies for low-input agriculture in less favorable environments. There is mounting evidence that this assumption is not valid, and that, in fact, the special problems of marginal environments and their farming systems must be addressed in new and innovative ways.

In those few cases where applying conventional breeding strategies to marginal environments has been questioned, it has been found that:

1. Selection in well-managed experimental stations tends to produce cultivars which are superior to local landraces only under improved management and not under the low-input conditions characteristic of the farming systems (Galt, 1989; Simmonds, 1991; Ceccarelli, 1994, 1996). The result is that many new varieties are released, but few, if any, are grown by farmers in difficult environments;
2. Poor farmers in difficult environments tend to maintain genetic diversity in the form of different crops, different cultivars within the same crop, and/or heterogeneous cultivars to maximize adaptation **over time** (stability), rather than adaptation **over space** (Binswanger and Barah, 1980). Adaptation over time can be improved by breeding for specific adaptation, i.e. by adapting cultivars to their environment (in a broad sense) rather than modifying the environment to fit new cultivars. Since diversity and heterogeneity serve to

reduce risk of total crop failure due to environmental variation, farmers may not abandon traditional cultivars;

3. When the appropriate cultivar is selected, adoption is much faster through non-market methods of seed distribution (Grisley, 1993), and, indeed, for many crops in difficult environments the informal seed supply system is the main, if not the only, source of seed, particularly for small farmers; and
4. When farmers are involved in the selection process, their selection criteria may be very different from those of the breeder (Hardon and de Boef, 1993; Sperling *et al.*, 1993). Typical examples are crops used as animal feed, such as barley, where breeders often use grain yield as the sole selection criterion, while farmers are usually equally concerned with forage yield and the palatability of both grain and straw.

Because the concepts of conventional plant breeding are not questioned, the blame for the non-adoption of new cultivars is variously attributed to the ignorance of farmers, the inefficiency of extension services, and the unavailability of seed of improved cultivars. Thus, enormous resources continue to be invested in a model of breeding which is unlikely to succeed in unfavorable agroclimatic conditions.

The contrast between the reality of the farming systems and the plant breeding philosophies is particularly striking in developing countries. This is not surprising. Most of the breeders from developing countries have received their training in those rarely-questioned breeding principles enshrined in developed countries.

## Specific Adaptation and Decentralization

Interactions between genotype and environment (GxE) are almost universally accepted as being among the major factors limiting response to selection and, hence, the efficiency of breeding programs (Ceccarelli, 1989). GxE interactions become important when the rank of genotypes changes in different environments. This change in rank has been defined as a crossover GxE interaction. When there is GxE interaction of crossover type between experimental stations and farmers' fields, it is not surprising that selection in high-input experimental stations does not allow the identification of the best genotypes for poorer conditions, and promotes genotypes which are, in fact, inferior in stressful conditions.

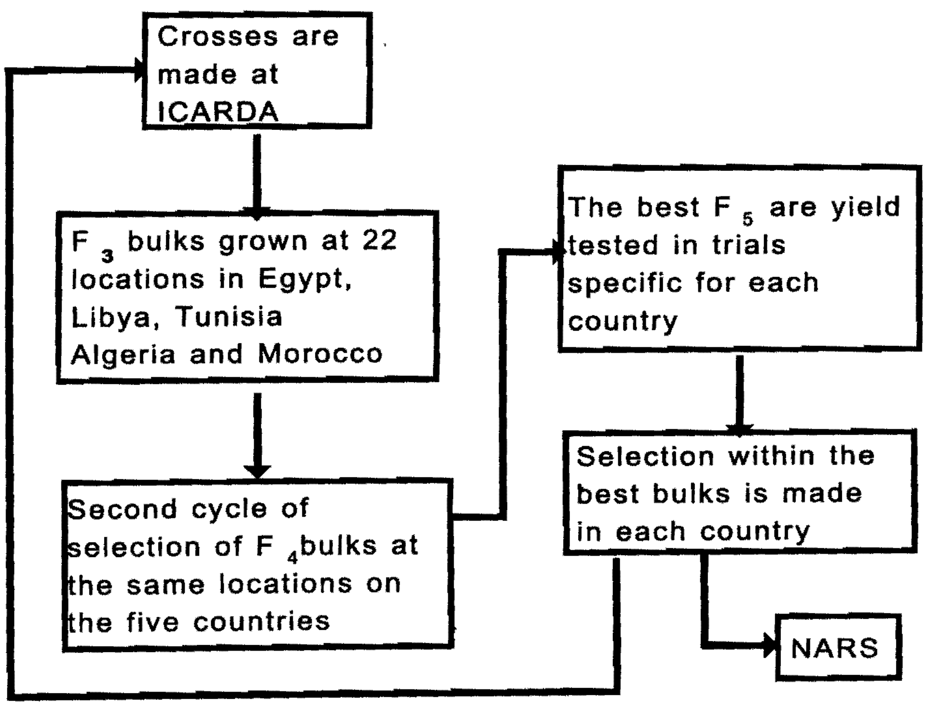
Formal breeding has taken a negative attitude towards GxE interactions of crossover type, in the sense that only breeding lines with low GxE interaction (that is high average grain yield *across* locations and years) are selected, while lines with good performance at some sites and poor performance at others are discarded. Because lines with good performance in unfavorable sites and poor response to favorable conditions have a low average grain yield, they are systematically discarded. Yet they would be the ideal lines for farmers in unfavorable locations. What this implies is that specific adaptation to difficult conditions must be found through direct selection in the target environments — not just on experimental stations.

To accommodate the concept of specific adaptation in a breeding program with an international mandate, we started to decentralize **selection** to NARS in specific geographic areas in 1991. The first geographic area to be chosen was North Africa because of its importance (it grows nearly 5 million hectares of barley), and because in the entire area only six-row barley is grown. In the five North African countries the scheme shown in Fig. 1 is now fully implemented.

This decentralized selection of early segregating populations in the target environment largely avoids the danger of useful lines being discarded because of their relatively poor performance at the experimental station (Ceccarelli *et al.*, 1994). It will be noticed from Fig. 1 that decentralization begins as early as the $F_3$ bulks (when enough seed is available), without any selection at ICARDA headquarters in the $F_2$.

Decentralization from international to national breeders is also much "greener", because it adapts crops to an environment, rather than vice versa, fewer chemical inputs are needed and biodiversity benefits because it favors the deployment of more varieties. Decentralization from international to national programs is in fact a drastic departure from the traditional one-way, "top-down" interaction between international and national programs (Simmonds and Talbot, 1992).

**Figure 1. Scheme of Decentralized Barley Breeding between ICARDA and five NARS in North Africa**



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However, our decentralized barley breeding for North Africa, although achieving NARS participation, does not necessarily involve farmers. Therefore, this type of decentralization may not respond to the needs of resource-poor farmers if it is only a decentralization from the experimental station of the IARC to the experimental station of the NARS; the latter is often no more representative of the difficult environments where the crop is grown. If we are to exploit the potential gains from specific adaptation, selection needs to involve farmers under their own conditions. Therefore, at ICARDA, farmers' participation is viewed as necessary to achieve all the potential advantages of decentralization.

## From GxE Interaction to Farmers' Participation

Farmers' participation in the ICARDA barley breeding program to date has been occasional and has consisted of discussions during field visits and occasional inspection and selection by farmers of breeding lines. The most significant outcome so far has been the inclusion by the breeders of plant height under drought and softness of the straw as selection criteria in breeding barley for dry areas.

A crop which remains tall even in very dry years is important to farmers, because it reduces their dependence on costly hand harvesting, while soft straw is considered important in relation to palatability. It is obvious that these two characteristics represent a drastic departure from the typical selection criteria used in breeding high-yielding cereal crops - short plants with stiff straw and high harvest index. Cultivars possessing the two characteristics considered important by farmers in dry areas would be unsuitable for high-yielding environments because of their lodging susceptibility, and in a traditional breeding program will not be made available to farmers — a further indication of the importance of specific adaptation.

## Barley Breeding by Syrian Farmers

In 1996 we began testing the possibility of incorporating farmers' participation as a permanent feature of a breeding program addressing difficult environments and low-input agriculture. We are doing this through a three-year research project supported by the Bundesministerium für Wirtschaftliche Zusammenarbeit (BMZ).

This research is conducted in the northern part of the Fertile Crescent lying in the Syrian Arab Republic. The area has average annual precipitation between 350 mm and 200 mm and encompasses a range of agroecological conditions, all of which may be considered as low-yielding environments for cereal production. Arable land is predominantly cultivated with barley landraces. The landrace barley cultivars are two-row, and known locally as *Arabi Abiad* (white-seeded) and *Arabi Aswad* (black-seeded). The first is common in slightly better environments (between 250 and 350 mm rainfall) and the second in harsher environments (less than 250 mm rainfall). Considerable phenotypic and genotypic heterogeneity exists both between landraces collected in different farmers' fields (even if designated by the same name) and between individual plants within the same farmer's field (Ceccarelli *et al.*, 1987, 1995).

The secret of barley's popularity among farmers and its continuing spread across the agricultural landscape, despite the failure to improve yields, lies in its adaptation to very harsh conditions and in its use as feed for small ruminants, essentially sheep and goats. Barley grain and straw are the most important source of feed for the small ruminants, which are the main source of meat, milk, and milk products, particularly for the rural populations.

Farmers consider that the quality of both the grain and the straw of the black-seeded landrace is better than that of the white-seeded. However, this has never been tested either in the field or under laboratory conditions, and the linkages between desirable qualities and specific uses are not clear.

The adoption of new, improved barley varieties has been virtually nil in Syrian rainfed agriculture. So this crop and this environment seem to be a good model to test the efficiency of decentralized and participatory breeding in comparison with decentralized but non-participatory, centralized and participatory, and centralized and non-participatory models.

A common set of 208 lines and populations (200 breeding lines representing an extremely wide range of germplasm plus eight farmers' cultivars) will be grown as unreplicated nursery with plots of 12 $m^2$ (8 rows at 20 cm distance, 7.5 m long) in three types of locations: a typically well-managed experiment station (Tel Hadya, ICARDA headquarters), an experimental site managed as a farmer's field and used in the past for decentralized non-participatory breeding (Breda), and eight farmers' fields under farmer's management practices.

The number of breeding lines used in this research is much higher than the one used in previous studies of this type. This is due to the need to include as much diversity as possible for traits such as row type (two- *vs.* six-row), phenology (early, medium and late-maturing types), plant height (tall vs. dwarf), lodging resistance (susceptible vs. resistant), disease resistance (susceptible vs. resistant), seed color (from white to black), stem size (from thin to thick), and others. Also, there was a need to include both landraces and modern varieties with sufficient diversity within each group. The breeding lines include both pure lines and heterogeneous populations to test the attitude of farmers towards heterogeneity, as opposed to the conventional breeders' propensity for homogeneity.

Discussions with farmers, as well as previous occasional participation of farmers in the selection of breeding lines in the experimental stations, would indicate that the number of lines used in participatory work does not necessarily have to be small. Probably the optimum number varies in different environments/countries and cannot be standardized.

Field locations represent a wide range of environments, in terms of both physical (soil type and fertility, elevation, rainfall, etc,) and farmers' practices (fertilizer use, rotations, date and method of sowing, land preparation, etc.). The co-operating farmers, **"host farmers"**, who will host the breeding plots and will make individual selections, have been recruited from the pool of participants in previous on-farm research as part of the long-standing Syria-ICARDA bilateral co-operative research program. Before selection, groups of local **"expert farmers"** will be identified and recruited on the basis of reputation, key farming contacts, past performance, representativeness of producer and consumer categories, and self-selection. The expert-farmer groups, together with the host farmers, will perform group selections from their respective host farmer's germplasm collections.

During selection, the traits that farmers select for (and the criteria they use in their selection) will be recorded by the breeders, economists and anthropologists, and compared with objective measures of traits, including the yield and quality of grain and straw, by barley breeders and by animal nutritionists.

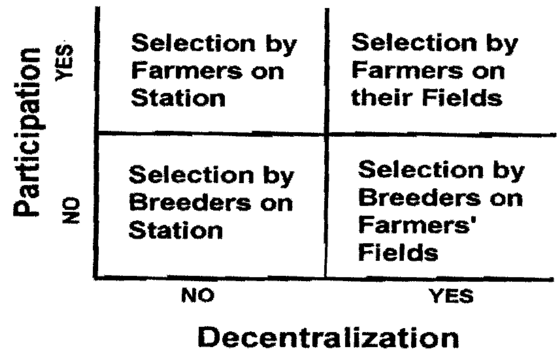
There will be four types of selection (see Fig. 2):

| | |
|---|---|
| **Centralized Non-participatory** | Done by the breeder at Tel Hadya. |
| **Decentralized Non-Participatory** | Done by the breeder at Breda and at each of the eight farmers' fields. |
| **Centralized Participatory** | Done by each of the eight farmers at Tel Hadya |
| **Decentralized Participatory** | Done by each farmer at Breda and in their own field (each farmer only selects in his field) |

The timing and the frequency of selection will be based on the information obtained in a parallel study of indigenous knowledge. Following a group selection procedure similar to that used by ICRISAT in Rajasthan, the expert farmer groups will be asked to select material from amongst those grown by their host farmers that they think would be useful for them and other farmers in their area. The selection will be conducted in such a way as to reveal the criteria being used by members of the groups when they make their choices. There will be detailed discussions, including both the expert farmer groups and the host farmer and breeders, regarding the cultivars selected and the criteria used in selection, farmer observations, expected performance, and crop management practices.

In the second year, all host farmers will grow the lines selected by the breeder in Tel Hadya and in Breda. In addition, each farmer will grow the lines he/she selected in Tel Hadya, those he/she selected in Breda, those he/she selected in his/her field, and those selected by the breeder in his/her field. Grain and straw yield data will be collected at each host farmer's field and at the experimental stations. Response to selection will be evaluated using the farmer's cultivar as reference. In the second and third years, selection will be done, as in the first year, on the lines resulting from the first and second cycle of selection. However, in the experimental station, each host farmer will only select from the material grown at his/her site.

**Figure 2. Decentralization and Participation**




Thus, during the second and third cycle (year) of selection, the farmers and the breeders will be exposed to the material selected by each other. During the selection process, the criteria of both the farmers and the breeders will be monitored and compared. Of particular interest will be the frequency with which the farmers, in the second and third year, select from among the material they selected themselves in the first year and from among the material selected in the first year by the breeder. This will give not only an indication of the consistency of farmers' selection criteria, but also an indication of the possible effects of fluctuations in environment over years on genotype performance and farmers' perceptions of these effects.

## Conclusions

The research project described in the paper will help to clarify some of the methodological issues in relation to participatory plant breeding, intended as participation of farmers in the selection of early segregating populations. From a breeding point of view, some of the most important questions that will be answered are:

1. Do farmers and breeders use similar or different selection criteria?
2. Which is more important — the environment where the material is grown or the person who does the selection? In other words, what is the key factor in increasing breeding efficiency: decentralization or participation?
3. Does participation increase the number of varieties adopted and the rate and the speed of adoption more than decentralization?

The answer to these questions would provide the basis for a very different type of breeding, characterized by a continuum between the formal breeder, with his/her capacity to generate large amounts of variability on experimental stations, and the farmer, with his/her comparative advantage in exploiting that variability in his/her own farming system and for his/her specific needs (Fig. 3).

**Figure 3. Links between formal plant breeding, farmers and informal seed system**

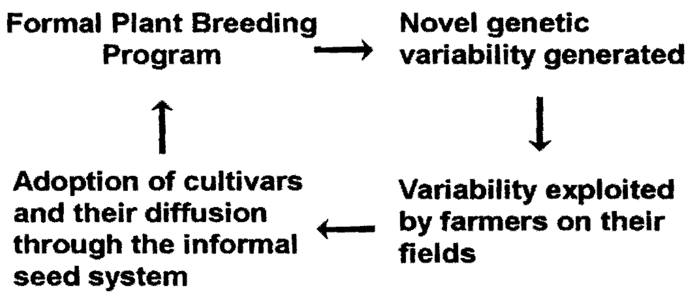



Figure 3 illustrates that participatory plant breeding cannot be limited to *ad hoc* studies conducted for a limited period to document indigenous knowledge and farmers' preferences. To be completely effective, participation should become a permanent feature of plant breeding programs addressing crops grown in agriculturally difficult and climatically challenging environments. For crops grown in remote regions, or for those considered as minor crops and therefore neglected by formal breeding, this could be the only possible type of breeding.

## Acknowledgments

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most important source of variation to consider in technology design, it is an underlying or hidden element. (Sarin) and the implications of technology and agreements about resource use should be clearly understood with that element constantly in mind.

One thing we do know about participatory research and shifting the demand for research and accountability to farmers' groups, is that participatory approaches are usually used with groups, often with the community at large. What we know about gender relations alerts us to the fact that the group process and joint decision making in a public setting often registers a consensus woven by the most powerful, while the voices, knowledge, and choices of other members of the community are not heard. This may have pernicious effects on obtaining adequate information and assessing technology options (losses in research efficiency) and may mean that the needs and preferences of silent groups are not addressed at all (equity).

There are four methodological challenges facing those who are interested in assuring that all the relevant voices are heard and considered in decisions about technology development:

1. identifying distinct (and overlapping) and relevant stakeholders or users;
2. finding ways to ensure that each category or group is part of the process of articulating its knowledge and priorities as well as collaborating on design and assessment if it is a relevant stakeholder in the issue in question;
3. determining priorities among and/or facilitating negotiations between stakeholders or stakeholders' choices;
4. measuring the contribution made to research outcomes by including stakeholders, and assessing the value of this.

**Identifying Stakeholders**

These are the directions indicated by gender analysis: learning 'who does what'; who has access to or control of resources; suggests sets of questions which can be asked of key informants early in a research project, or even as part of a group exercise with activities or calendars. With respect to germplasm enhancement, this may be sufficient to identify who is the most knowledgeable and who will be chiefly responsible for different aspects of the production and use of that commodity. But one must be attuned to both the questions and the answers. In Peru, according to Maria Fernandez', it took more than a year for the research team to hear 'who does what' and identify women as the experts on livestock and men on field production. In the Indian situation described by Madhu Sarin (see below), women did not see themselves as stakeholders, yet their interests were severely affected by decisions made by others.

In natural resource management, the identification of stakeholders is likely to be more complicated depending on (a) what level is being addressed: field, farm, or watershed and community, and (b), the nature of the problem. For technologies designed to improve water retention and soil organic matter at the field and farm level (what I call NRM1), 'who does what' within the household may suffice to indicate the relevant stakeholders. Where investments in land improvements are considered, differential control of land may affect the actual as compared to the optimal pattern of such investments. Are the costs and benefits of the proposed solutions distributed equitably? Margreet Zwarteveen of IIMI has just written an award-winning paper on the association of women's land rights with productivity in Burkina Faso. In households where at least one woman has a plot of irrigated land in addition to that owned by her husband, both the productivity of land and the productivity of household labor on both plots is greater than in households where only men have plots, i.e. where women have no guaranteed benefits from irrigated production.

When a larger landscape is operative, such as a watershed or the use of common property resources (NRM2), there are externalities involved and a wider group of stakeholders to identify. For instance, consideration must be given to upstream and downstream users of an irrigation system or to residents of different niches in a common watershed. This will require a more probing set of questions to key informants or community groups, both to identify, or to allow people to self-identify, their different interests and knowledge with respect to the NRM questions at issue.

How do we identify users? There are two overlapping dimensions which may help us distinguish between the various kinds of users and stakeholders. There are **categories of people who share certain characteristics,** such as female-headed households (though there are important elements of differentiation among them), or hired male laborers, or the landless. They are particularly important to us when they have a particular relationship to the research problem, such as responsibility for the crop in question, or for a particular task, like weeding or ploughing. Researchers and policy makers may fall into this category with different interests at stake in solving a particular set of problems. Second, there are **groups of people** which are organized, have some internal cohesion and a sense of common purpose. Groups may be organized around (a) particular resource or set of tasks (irrigation management), (b) an institution such as work groups, church, savings association, kinship groups or neighborhoods; or, for researchers, their national and local research and extension institutions.

But the use of categories needs to be done carefully, with an awareness of the complexity of individual allegiances. For instance, the use of gender as a differentiating variable does not imply the homogeneity of women or men or children. For example, women may be differentiated by whether they are cultivators (owners) or hired labor, OR hired labor may be differentiated by whether it is male or female. Gender categories — men, women, children, household position and life cycle stage — are cross-cut by wealth, ethnicity, caste, and so forth.

# METHODOLOGY ISSUES IN DIFFERENTIATING USERS OF NEW TECHNOLOGIES: PARTICIPATORY RESEARCH AND GENDER ANALYSIS FOR TECHNOLOGY DEVELOPMENT

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The goal of this system-wide initiative is to develop, test, and refine methodologies of participatory research and gender analysis as they apply to the development of new technologies in germplasm enhancement and natural resource management. The objective of this paper is to suggest

- what the researchable issues are for improving methodologies and providing guidance in PR and GA;
- how user differentiation and gender analysis fit into a comparative framework which can be used across all sites

There are many different degrees or kinds of participation which will be discussed more generally here. The important element from a user and gender perspective is whether or not:

- different kinds of stakeholders have an equal or fair chance of being involved;
- particular kinds of stakeholders get the priority attention they need.

In the discussion which follows, I am drawing upon my own experience in attempting to introduce gender analysis and a gender perspective into IARC research agendas and protocols as well as a continuing conversation with the MERGE[4] project at the University of Florida which is addressing similar issues with respect to natural resource management.

Gender analysis has been around for a while, but its uptake has been slow. What is needed to improve the methods for, and uptake of, gender analysis and user-differentiated participation as a research tool?

- More 'proof' that gender or other differentiation makes a difference. Quality examples from excellent sites are frequently met with scepticism because it is not the researcher's region or commodity or what have you. Therefore more Center and NARS research in collaboration with farmers and NGOs which indicates positive benefits in research outcomes from using gender analysis and als takes account of different users or stakeholders, will help to build a body of Center and NARSs experience more easily learned by others operating in the same framework.

4 Managing Ecosystems and Resources with a Gender Emphasis.

- Better understanding of the efficacy of different methods or refinements to ensure that different stakeholders' interests are heard and considered equally.
- Guidelines for different circumstances, such as cultural or regional contexts or the nature of the research problem.
- Better understanding of how addressing the needs of particular groups may have benefits for wider groups (in addition to trickle-down, which is the standard assumption).

By addressing these issues systematically and across a number of sites, this system-wide initiative will make considerable progress in improving methods and uptake of user differentiation as a research tool.

This paper is about user differentiation, but I will start with reviewing the different interpretations of gender analysis. First, I want to be sure we understand the differences and do not talk at cross purposes. Second, the task of bringing women into the category of relevant users or participants is not always straightforward or easy, and it has lessons with respect to differentiating and including users differentiated by other variables, such as wealth, ethnicity or caste.

There are three different ways in which gender analysis is usually considered:

1. Gender analysis in agricultural research has generally been interpreted as referring to the roles and resource use of categories of people differentiated by age and sex, i.e. **who does what.** It provides a snapshot of who does what in order for researchers to identify the most appropriate collaborators, i.e. who has special knowledge or responsibility or some other stake in the particular research question, whether it be a commodity or resource management. This is the **efficiency** argument and is at the heart of the issues addressed in this system-wide initiative.

2. Increasingly, there is a wider acceptance of interpreting gender analysis to include an understanding of the **gender relations** between men and women in order to understand how those relations — differences in resources and in power — affect men's and women's choices. This use of the term, widely used as such in Europe and in the South, is more **equity oriented** and has an inherently political dimension. It also focuses our attention on structure and power relations within a wider community.

3. Going even further with respect to **equity** and often addressing issues of **empowerment,** is the recent priority given by the CGIAR to technology development which is relevant to and meets the needs of **poor rural women**. TAC expects to review upcoming MTPs with regard to that dimension.

Whatever the reasons for bringin in gender analysis, we know that it is a powerful tool for finding out who are the stakeholders in any particular situation. We know that gender is an important variable in every society. Even when it is not immediately visible not even the

*Questions*

- What methods are best for identifying different stakeholders? 'Hidden' stakeholders?
- What are the appropriate levels of aggregation or disaggregation of user categories?

**Ensuring Participation and Consideration**

This is the heart of the challenge which lies before us. As Louise's work has shown, identifying that women grew beans in Rwanda emerged relatively simply from 'who does what; who knows what'. Enlisting the right women , those recognized by their peers as experts, took considerable footwork. It also meant overcoming considerable hesitation on the part of some of the women and some of their husbands about their involvement in such a public and distant domain as the research station. In a later attempt to enlist women to assess bean varieties in Zaire, already organized women's groups were asked to elect a representative to come on station. This election did not always mean that the representatives had expertise, and once again, some of them ran up against male reluctance for women to move 'out of their place'.

Madhu Sarin recently presented a paper on the FAO email conference on Conflict Management with respect to women and marginalized people. She demonstrates in two case studies how decisions made at the community level were dominated by male or higher caste groups, ignoring the relevance of their decisions to the work they expected to their wives or to lower caste communities. In this case, to protect the forest for commercial timber purposes, no cutting was allowed. Women, whose responsibility it was to get fuelwood for cooking, had to go much farther, often entering the forest preserves of another community and putting themselves at risk of being caught by forest guards. An NGO worked carefully with the women to help them make their circumstances and needs visible to the wider community. This resulted in new arrangements which addressed more realistically the women's need for firewood and the protection of certain species for timber. Sarin makes the point that women were stakeholders, but to themselves and their husbands, their stake was invisible. It took careful observation and discussion for their stake to be visible and taken into account.

There are a number of common constraints on inclusion of women and other marginalized groups in participatory research related to technology development:

- They are not included in the public domain; and are literally or metaphorically restricted to the private domain.
- They are shy in the public domain and will not reveal their knowledge or concerns.
- They do not self-identify with the research question, even though they may be involved in the enterprise or landscape at issue.
- They are not allowed to speak to male researchers, especially one to one.

- They speak a local language rather than the more widely used lingua franca of researchers and community leaders.
- Their own schedules are very busy and it is difficult to find where and when to work with them.
- They require husband's or senior male's or mother-in-law's permission to engage in work or discussions outside their usual tasks.

Several strategies and modifications of existing participatory methods have been devised to ensure that women's or other stakeholders' voices are heard:

- Interviews or exercises are conducted separately for men's and women's groups: maps, transepts, matrices, life histories, focus or community interviews, wealth ranking, venn diagramming, etc. A number of examples of this are shown on the IIED film: A Question of Difference. Results of the separate exercises can then be compared by the larger community to identify common and different knowledge or interests.
- Separate trials and field days are held to test technology options and discuss results.
- Researchers engage in participant observation in places where women work and with tasks done by women.
- Female researchers, field assistants, and enumerators are included on the team.
- In joint or separate meetings, questions are asked about tasks or enterprises which are known to be in the women's domain. For instance, questions may be asked about home gardens which may be experimental plots for crops grown in fields.
- Researchers collaborate with pre-existing women's groups
- Researchers work with NGO partners who already have access to women's groups

These constraints and the means for overcoming them (and others, I hope, generated by the group here) may apply to other sets of users, particularly those who come from marginalized groups. How necessary extra measures are, how culturally specific, how effective in different circumstances and at which stages they are important is something we will want to compare across sites. We know already that the questions of access and visibility for women as collaborators varies considerably between regions.

Finally, the effort taken to ensure distinct voices are heard will be as naught unless the knowledge and other insights they provide is considered in a disaggregated form, whether by researchers or the community.

*Questions*

- How can we insure the participation of "invisible" or lowly regarded groups?
- What kind of participation is appropriate at different stages of research?

**Determining Priorities among and/or Facilitating Negotiations between Stakeholders or Stakeholders' Choices**

Sarin describes communities as a'dynamic hierarchy of social relations which determines [each group's] relative ability to exercise power and authority' (Sarin 1996). Current power relationships and local perceptions of relevant interest will shape the initial investigation. They will depend a great deal on the relative roles of (particular) farmers or community leaders and researchers. They may be configured by the narrowness or breadth of the mandate and capacity of the research organization, and the stage of research in question. For instance, we wouldn't expect potential for conflict to be as great in germplasm enhancement as it would be in natural resource management. Priorities also may be shaped by the concern of donors for particular groups. They may depend on the relative contributions of, and the perceived distribution of benefits by, different groups.

For instance, in Botswana, the Appropriate Technology Improvement Project determined through on-farm testing, that ploughing before rains would result in better water retention after rains and a bigger boost to the germination and growth of sorghum. However, ploughing was generally done by men whose priority enterprise was cattle; the benefits of this technique — increased productivity of sorghum and reduced weeding — accrued principally to women, who were responsible for crop production. There was therefore a reluctance by the men to contribute their cattle for timely ploughing. Recognizing their inability to change these interests, the research team began work on other strategies which would increase women's sorghum production and were not dependent on men's input (Baker 1989).

In a paper discussing methodologies for identifying and weighing the importance of different stakeholders in community forest management, Colfer, Wollenberg, and Prabhu have come up with a matrix model. On the left are different kinds of stakeholders identified by early diagnostic activities, in this case, ethnic groups. Cross-cutting these categories are 'dimensions' of relatedness to community forest management, e.g. proximity, local knowledge, dependency, power vis-a-vis other stakeholders, etc. Each stakeholder category or group was rated from 1 (high) to 3 (low) with regard to the six dimensions. The average scores for each stakeholder were computed and the stakeholders were then ranked for their relative importance in respect of community forest management. Some such scheme might be useful for identifying stakeholders in the proposed PPB and NRM research where different interests may be in conflict.

In some situations, a careful estimate of the collective costs and benefits and decisions about compensatory mechanisms across the landscape have been negotiated between various groups.

With the objective of working out plans for community-managed conservation by communities and conservation groups interested in preservation of particular areas of biodiversity, the MERGE group, based at the University of Florida, has begun by training community trainers in community planning in participatory workshop format. In using each technique, gender and other variables are taken into account. The format includes specific attention to gender issues, making visible everyone's roles, priorities, and stakes in the plan.

For agricultural research, identifying different stakeholders and addressing what may be different interests and preferences is a relatively new area. It isn't tidy. It may bring us directly up against our personal values and politics. We need to explore further to find what approaches other groups may have tried. As we find these situations in the pilot sites, we should be testing and documenting different approaches and the context and issues in which they are addressed.

*Questions*

- Who should establish priorities?
- How should the relative merits or value of different stakeholders be assessed?
- What methods or strategies will improve negotiations among, and reduce conflicts between, stakeholders?

## Measuring Impact

With regard to assessing the value of including gender or other differentiated users in participatory technology development, it is difficult to have a 'with' and 'without' situation. Given location specific variability, it is difficult to reliably compare the 'without' situation to the 'with' situation. A preferred means of assessment would be to undertake transparent and systematic documentation of the decisions and actions taken to include different users in the development of specific technologies, including the management of natural resources management.

In such a strategy, participants and researchers would undertake a preliminary, diagnostic gender analysis (including other variables) to determine who are (potential) stakeholders at this site, on this problem, with some indication of what their stake might be. The next step is to determine and record why which stakeholders should be involved in the intended research. The research begins then with a base line on who is doing what and the choices and reasons for focusing on specific groups. From then on, we should document and cost out each step of the research process as it proceeds including any extra or reduced costs of different methods of ensuring the participation of the various stakeholders and the contributions that such methods or refinement bring to the analysis of the problem and to the design and testing of technical solutions. Next, we should document the impact along the dimensions listed below. For each site, there will be a record of the pathway, steps taken, their costs and contributions. A comparison can be made by comparing the costs and benefits of the additional information, reliability, ownership, etc. to project outcomes and impact. Cross-site comparisons will depend to some degree on their variability as to region and kind of research objectives. Some modifications, such as including female researchers, or working separately with women's group participatory exercises, may be more necessary in one region than another and will help in providing guidelines as to which methods may be most useful in different circumstances.

What are the expected results from participatory, gender and user-sensitive technology development? How can we measure them? There are seven dimensions to be explored. These are all objectives of international agricultural research and of user and gender-sensitive participatory approaches, though we may differ as to which are most important. This initiative provides us with an important opportunity to measure impact in several dimensions. Let us see what these methods contribute to each:

- The acceptability by farmers as measured in the rates, extent and speed of adoption.
- Reduced costs, greater cost-effectiveness of research.
- The efficacy of various user-differentiated participatory methods in various contexts.
- Contributions of the technology to productivity-enhancing and resource-conserving sustainability; retention of biodiversity; measuring all three technically.
- The impact on family welfare or livelihoods as measured within the household and within the community.
- The impact on, or relevance to, specifically, poor rural women and other marginalized groups (i.e. improves their livelihoods and welfare; equity).
- The impact on the position of poor rural women; that is, their ability to access resources and make decisions about their own livelihoods is improved. (empowerment).

To do this, 4 steps are suggested:

1. Document the context--region, cultural, scale, type of problem addressed, etc.;
2. Identify criteria and associated indicators for each of the above impacts along with base-line data for indicators to be collected at the beginning of our work in pilot sites. (cf. Colfer, Wollenberg, and Prabhu 1995);
3. At each site and for each stage of research, document the methods used and reasons why, in order to identify, ensure the participation of, and consider the priorities of different stakeholder groups;
4. Document the actual involvement of different stakeholders at each stage of research along with the costs and estimated benefits of their involvement. Such benefits include contributions to research as well as changes with regard to the group's identity or power.

An analysis of the steps taken and the pathways tracking the methodologies and refinements used through to the research contributions and results could be summarized as in Figure 1 and compared across sites.

## *Questions*

- Who should assess impact?
- What should we measure?
- How shall we measure it?

**Figure 1. Example of tracing pathways on the use of gender analysis and other methodologies for the identification and inclusion of differentiated stakeholders and their contributions to technology design and project impact**

| **Research context & objectives** | **Methods used for stakeholder identification** | **Inclusion: Participatory method** | **Inclusion: refinements for including different users** | **Contributions: participatory method** | **Contributions: user refinements** | **Results for technology design** | **Project impacts** |
|---|---|---|---|---|---|---|---|
| | • key informant inteviews<br>• community enterprise analysis | • maps | Separate: men and women | • natural resources, enterprise locations, different neighborhoods | Men's and women's different knowledge and priorities | | 1. Acceptability by farmers; adoption<br>2. Greater cost effectiveness of research |
| | • transcept<br>• wealth ranking | • transepts | Joint | • natural resources, enterprise management, landscape history | ? | | 3. Contributions of the technology to sustainability, measuring both |
| | | • venn diagram | Separate: men and women; owners and hired labor | • important stakeholders, potential alliances | Differences in perceptions of who are stakeholders; additional stakeholders identified? | | 4. Impact on family welfare as measured within the household<br>5. Impact on or relevance to, specifically, poor rural women and other marginalized groups |
| | | • participant observation | Female researcher with women during communal weeding | Importance of weeding to crop production; insect identification; constraints to weeding... | Same | | 6. Impact on the position of poor rural women (empowerm't)<br>7. The efficacy of various user-differentiated participatory methods |

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# METHODOLOGY ISSUES IN STRENGTHENING FARMERS' RESEARCH AND TECHNOLOGY DEVELOPMENT

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## Introduction

The present meeting is a result of the growing interest in alternative approaches to agricultural research and technology development. The transfer of technology (TOT) approach for agricultural research and extension serves industrial and green revolution agriculture. Decisions in research and technology development are made by scientists; technologies are handed through extension to farmers. It is increasingly being recognized that the TOT-paradigm is inappropriate for agricultural systems in complex, diverse and risk-prone environments.

A new and complementary paradigm for agricultural research, development and extension has emerged. This paradigm has some roots in the recognition of the failures of conventional paradigms by groups of scientists, mostly active in social science and development-oriented research. A major component of the new paradigm is the recognition of the capacity of farmers themselves in research and technology development (Chambers *et al.*, 1989). Farmers in complex, diverse and risk-prone agricultural systems can hardly be considered clients of technologies generated in the institutional sector, since such technologies are mostly not appropriate. In many cases, those farmers are resource-poor and do not have the income to purchase inputs. Farmers' own capacity in research and technology is therefore the primary innovative component in such low-external input agricultural systems.

Different approaches to participatory research have evolved over the last decade. This range of approaches varies along with the objectives of the actors involved in participatory research. Following an introduction on farmers' experimentation, the paper introduces three perspectives to participatory research. We will use these perspectives to analyze different participatory approaches in relation to farmers' own research and show how they can be strengthened. The case of seed system development and farmers' research in the management of seeds and varieties is elaborated. This case gives insights on the different roles of actors in such a field. Various approaches in participatory plant breeding are evaluated for the type of interaction with farmers.

Our personal and professional commitment in the present field is to contribute to the emergence of participatory and integrated approaches in the management and utilization of plant genetic resources, plant breeding, seed supply and related regulatory frameworks. The organizers of the seminar have asked the discussion openers to contribute to the debate in a rather provocative manner. Many of the participants involved in social sciences, plant breeding or development-oriented/activist NGOs may find our contribution biased and inadequate. That is the price that we have to pay in fulfilling the request of the organizers. It is also a price that we pay in the world of science and development, balancing between plant breeding and plant genetic resources management on one hand, and grass-roots development on the other hand. So be it.

## Farmer Experimentation

Farmers have always experimented to produce locally appropriate technologies and practices. An important illustration of the dynamic nature of farmers' innovative capacity is the fact that when they are faced with a new technology or practice, they rarely adopt or reject it immediately in its introduced format. If technologies are appropriate and fit the specific conditions, farmers may consider adoption. If not, they may try, if possible, to adapt in a continuous process of experimentation, or they may eventually reject.

Formal conventional research commonly does not consider farmers as experimenters. Farmers are assumed to be conservative by nature. This image results in research which characterizes, analyses, validates, and enhances "static" farmers' practices. Such approaches in studying farmers' experimentation obtain snapshots of a complex and dynamic process (Pretty, 1994). Farmers' knowledge is viewed as primitive and unscientific. Conventional research and extension take the attitude that development requires that farmers' knowledge be transformed and replaced by scientific knowledge. Science appears to be synonymous with or a precondition of development.

An alternative approach to farmers' experimentation considers farmers' knowledge to be a valuable resource. Farmers' knowledge can be collected, evaluated and merged into development activities. This approach is elaborated and advocated in Farmer First approaches in participatory research and Participatory Technology Development (Chambers *et al.*, 1989; Reijntjes, *et al.*, 1992). Another alternative approach has emerged within this context. Farmers' local non-western general science is regarded as being unitary "bodies" or "stocks" of knowledge. Farmers' and scientists' knowledge are regarded as different epistemological constructs within particular agroecological, sociocultural and political economic settings (Scoones & Thompson, 1994); they change constantly and evolve within society. These changes depend on the dynamic interactions between actors and institutions, and the power relations between them. Participatory Action Research (PAR) is one of the approaches addressing these power relations. The third approach to farmers' experimentation provides a different understanding of the functions of scientific and farmers' knowledge and of processes of agricultural innovation (Pretty, 1994).

## Perspectives to Participation

Why do scientists get involved in participatory research? What is their goal? To answer these questions, three perspectives to participation will be elaborated, each reflecting on the interaction between farmers and the external actors (scientists, extensionists or development workers). These perspectives vary according to the function of these external actors, and their goals in working with farmers. The first perspective is primarily focused on research efficiency. The scientists' goal is to enhance the efficiency and impact of their research activity and, they envisage a better efficiency through the involvement of their clients in the research process. The second perspective has a diversity focus. Approaches with this perspective build partially upon farmers' research capacity to develop a range of solutions (basket of options) to the complexity of problems. Approaches with the third perspective are built on empowerment and political goals. Participation is considered an instrument to empower farmers in their access to and management of information and resources.

### *Research Efficiency Perspective*

Improvement of the efficiency of the research process is one of the goals for scientists to include participatory research in their technology development activities. The foundation for this approach is that increased involvement of the clients in the research process facilitates the development of more appropriate technologies. Participation is used as a tool to increase client orientation, and this aims at a higher adoption of technologies by farmers. Farmers participate in various stages of the research process. The scientist - farmer interaction can be characterized as nominal, contractual and consultative modes of interaction (Ashby, 1990; Biggs, 1988). A very common form of "participatory research" within this perspective is researcher designed and implemented, and conducted on farmers' fields. The flow of information within approaches with this perspective is primarily directed by the scientists, as the main goal of the approach is to improve the efficiency of their research work.

### *Diversity of Options Perspective*

The generation of a range of options (technologies or options) to a diversity of problems and conditions is another reason for scientists to become involved in or initiate participatory research. Farmers' research capacity in experimentation is recognized and utilized in the scientists' research process. The "basket of options" (Chambers, 1993) developed in such participatory approaches is expected to provide farmers with technologies which are better adapted to complex, risk-prone and diverse environmental conditions. A larger number of farmers in more diverse environments can benefit from the technologies and information generated in such a participatory process. Farmers and researchers collaborate in various stages of the research process and, the scientist - farmer interaction is of a consultative and collaborative nature. Scientists have a key role in the prioritization and design of the process (Biggs, 1988). Participatory Technology Development (PTD) is an example of such an approach, in which the knowledge and research capacities of farmers are joined with those of scientific institutions. PTD at the same time aims to strengthen local capacities to experiment and innovate (Haverkort *et al.*, 1991; Reijntjes *et al.*, 1992). Information within this approach to participation flows more equally between scientists and farmers. The intensity and direction of the flow of information and the level of control over the resources involved depends on the stage of the research process. Scientists control and utilize information obtained through participation in the early stages of the research, in the later stages the flow of information and resources is directed more by farmers.

*Empowerment Perspective*

A third perspective on participation treats the farmers' own innovative and experimental capacity as a form of inquiry in its own right. Within approaches based on this perspective, farmers' research is not valued according to the criteria of Western science. Such approaches change the roles of and the relationships between researchers, extensionists, development workers and farmers. It is a process of mutual learning as colleagues with different contributions (Chambers, 1993). Such approaches create opportunities for the development of methodologies for sharing farmers' innovative capacity with other farmers and with researchers, each on their own terms. Participatory Action Research (PAR) is one of these approaches in which the empowerment of rural people is the major goal. Such approaches are operationalized through conscientization (Freire, 1970), activism or confrontation (Fals-Borda & Rahman, 1991). PAR promotes local-level learning, analysis and action. In this setting, the external actor (researcher or development worker) is still influential, but the research is so bound up in the action that the influence is seen as part of a participatory, empowering and political process (Cornwall *et al.*, 1994). The interaction between scientists or development-workers and the farmer has a much more collegiate character (Biggs, 1988). Research activities are an element of the empowerment process. Farmers and scientists make joint decisions in the research process and in the management and control of resources and information.

*Beyond Perspectives*

Participatory approaches mean different things to different scientists, development workers and activists. Their perspectives to participation are highly dependent on their institutional and political background. Similar interactive, visual tools and techniques developed in various participatory approaches can be used in diverse settings. They can be used to deliver an extension message to people and to extract farmers' knowledge and information within the process of "external" research and technology development. In action research, they may be used as tool in a joint learning process empowering rural people.

The approaches within the three perspectives are not mutually exclusive. An integrated approach drawing on the strengths and potentials of each is the best option. The research efficiency and diversity perspective are used by researchers involving farmers as partners in their research. When farmers' research is made central to the activities (as in the empowerment perspective), external actors strengthen farmers' capacity to assess and solve problems themselves.

The institutional and professional environment of research needs to be addressed when strengthening farmers' research and technology development. This is central to participatory research. Interactions between the actors, a stimulating learning environment, and negotiation in joint planning and implementation in action-oriented research require new professional attitudes. The institutional environment needs to encourage the spread of participatory approaches between and within institutions, thus giving innovators the credit and freedom for acting and sharing (Pretty & Chambers, 1994). Approaches and methods developed within this perspective to participation would signify a change in research, moving initiative, responsibility and action downwards in hierarchies, especially towards farmers and rural people themselves (Chambers, 1993; Cornwall *et al*, 1994).

Scientists within different organizations like the CGIAR institutes, NARS, universities and NGOs have very distinct roles in the diversity of participatory approaches. The skills and scientific expertise of individual scientists should be valued and not be drowned in interdisciplinarity and participation. It is the art of interdisciplinary and participatory research to acknowledge and utilize specialists in their own fields. These specialist should, however, have the communication skills to work together in teams with specialists from other disciplines, and have the capacity and desire to work with farmers in a collaborative and collegiate mode of interaction (Mettrick, 1993). The realization of participatory activities involving different actors in research and development should be based on joint action in different stages of the research.

## Perspectives to Participation in Seed System Development

### *Local and Institutional Seed Systems*

Local crop development is described as the continuous and dynamic process in which farmers manage crop diversity within a specific agroecological and socioeconomic environment (Hardon & de Boef, 1993). Elements of local crop development are: the exchange of varieties (seed flow); their maintenance and utilization (variety selection); their enhancement (variety adaptation); and seed multiplication, processing and storage (Bellon *et al.*, 1996). Varieties are maintained, adopted, adapted, displaced and exchanged. Local crop development is built on farmers' knowledge and capacity to experiment with germplasm and seeds. The farmers' knowledge develops through the utilization of reproductive material for crop production (de Boef *et al.*, forthcoming).

The development of private and public seed sectors has resulted in the establishment of what could be described as an institutional seed system parallel to the local seed system. Components of the institutional system are conservation in gene banks, breeding, seed production, processing and marketing, and regulatory frameworks for varieties and seeds. Varieties are developed in a linear process in the institutional seed system. In private companies, information on client preferences is obtained primarily through marketing channels. Such channels are less prominent in public organizations, in which government policies are given higher priorities than client preferences. Source material for plant breeding is obtained from gene banks, which have collected most of these resources in local seed systems. The products of the institutional seed system - seeds of improved varieties - are distributed through marketing channels. The entire process of variety development and seed production takes place within the institutional system with little interaction with local systems (de Boef *et al.*, forthcoming).

This presentation of parallel local and institutional systems puts seed development in a somewhat black-and-white perspective; it does, however, reveal how the institutional seed system ignores farmers capacity to experiment. The institutional seed system has strong roots in the transfer-of-technology-paradigm of agricultural research and development. It has put farmers at the end of the linear process of variety development. On the other hand, one of the main products of the institutional seed system - modern varieties - has been adopted by local seed systems even though many of the components of the chain (seed multiplication and dissemination) are weak. Modern varieties, once proven to have a higher productivity or valued qualitative traits, are easily and quickly spread among farmers through the local seed system. The fact that modern varieties have been disseminated amongst farmers rapidly through the local seed systems is hardly recognized.

Various approaches in linking up with farmers' experimentation in crop development have evolved in the institutional seed system over the last decades (Van der Heide *et al.*, 1996). The conservation of plant genetic resources on-farm and *in situ* is becoming recognized and integrated as a complementary strategy (Bellon *et al.*, 1996; Hardon & de Boef, 1993; IPGRI, 1993; 1996; FAO, 1996). Participatory plant breeding and participatory varietal selection aim at involving farmers in the plant breeding process (Berg *et al.*, 1991; Eyzaguirre & Iwanaga, 1996; Hardon, 1995; Sthapit, *et al.*, 1996; Witcombe & Joshi, 1996). Integrated seed supply systems are proposed, building linkages between formal and informal seed supply systems at various levels (Almekinders *et al.*, 1994).

The regulatory frameworks for varieties and seeds are restricting the potential interaction between farmers and researchers. Elements for open legislation are being developed which promote and permit participatory and integrated approaches in seed system development (Louwaars & Ghijssen, 1996; Tripp & Louwaars, forthcoming; Tripp & Van der Burg, forthcoming).

*Perspectives to Participatory Plant Breeding*

Participatory approaches in plant breeding have primarily developed within the efficiency and diversity perspectives on participation. Interactions with farmers are used to evaluate breeders' selection criteria, to improve the process of plant breeding, and to increase the adaptation of varieties to farmers' conditions. The different approaches in participatory plant breeding have been developed from different components of the breeding cycle (Weltzien *et al.*, 1996).

The perspectives elaborated earlier are used to reveal the goals for participation in these participatory plant breeding approaches. Box 1 presents the different approaches as interactions between institutional and local seed systems. The different perspectives give an indication what the expected outputs are for the different actors involved in the participatory activity.

The perspective of the plant breeders in many of the participatory plant breeding activities is to recognize, validate and extract farmers' research capacity and to collaborate with farmers in plant breeding. When the diversity and empowerment perspectives are used, access to information and materials for the farmers involved is thought to increase remarkably. This increased access to information and materials can be considered a secondary output of interaction. Although the involvement of farmers in the research process may result in democratizing plant breeding activities, the farmers' influence on the research process using the empowerment perspective is limited. The goals of plant breeders with regard to participation are rooted in the perspectives of increasing the efficiency of their plant breeding work and enhance the development of diverse and more appropriate materials.

Activities as elaborated in the Community Biodiversity Development and Conservation (CBDC) Program are built with a strong empowerment perspective on participation. The primary objectives of the program are to strengthen and support the local (community) seed system and, where appropriate, involve institutional partners (CLADES *et al.*, 1994; Montecinos, 1994). The assessment of the local seed system in some of the CBDC projects is organized in an integrated manner, identifying the constraints and developing ways in which these problems can be solved by the communities themselves. Where necessary, scientists within the institutional seed system will be approached by the local organization to support the community-based research process. While some of the tools and methodologies used in CBDC appear similar to those developed within NARS and CG institutes for participatory research, the perspective and setting are completely different. The emphasis on empowerment within CBDC is rooted in the strong development orientation and activist background of the NGO partners in particular within the CBDC program (Manicad, 1996).

*Approaches in Participatory Plant Breeding*

1. *Inventories of problems, constraints and potential solutions in farmers' seed systems are an important basis for many grass-roots and development-oriented seeds and PGR-projects. On the basis of these inventories, opportunities for the development and enhancement of the local seed system can be identified. Research*

*activities (involving scientists) are initiated following the assessment (CLADES et al., 1994). Farmers set research agendas in these activities and, on the basis of these, scientists then become involved.*

2. *(Re-) introduction and direct distribution of germplasm to farmers by gene banks is considered an element of in situ conservation (Bellon et al., 1996; Worede & Mekbib, 1993); (re-) introduction increases farmers' access to genetic resources and thereby stimulates and strengthens local seed systems (CLADES et al., 1994).*
3. *Teaching farmers to identify good parents for breeding and to make crosses themselves is a way of stimulating farmers' research in crop development. Specialist farmers may be partners in such activities, which are elements of projects where there is primarily an empowerment perspective (Berg, 1996; CLADES et al., 1994; Salazar, 1992). Putting the basis of the breeding process in the hands of farmers directs the interaction with plant breeders towards strengthening local capacities (joint learning and action) and, for example, towards providing farmers with materials (interesting "foreign" genetic resources).*
4. *Running participatory rural appraisals (PRAs) to identify farmers' priorities and selection criteria is used as a diagnostic tool for plant breeders to identify and validate their goals in plant breeding (Joshi & Witcombe, 1995; Weltzien et al., 1996). PRAs were originally developed to empower people to articulate constraints and identify potential solutions.*
5. *Involving farmers in selection practices on-station is another example of utilizing farmers' capacity in the breeding cycle. Such involvement in on-station selection partially empowers the farmers involved; it increases their access to materials and information (Ceccarelli et al., 1996; Sperling & Loevinsohn, 1996; Zimmermann, 1996).*
6. *Disseminating segregating materials (varying from $F_2$ to $F_8$) to farmers is a way of testing these farmers (CLADES et al., 1994; Sthapit et al., 1996; Weltzien et al., 1996) . A collegial interaction between breeders and farmers in such activities results in a learning process both for farmers and breeders. Such approaches democratize selection. They also increase farmers' access to advanced materials. The interactions between the breeders and farmers provides learning opportunities for enhancing capacities and directions in selection.*
7. *Participatory varietal selection (PVS) is a way in which the plant breeders are supported by farmers in the identification of appropriate advanced lines or varieties for release (Ceccarelli et al., 1996; CLADES et al., 1994; Cordeiro, 1993; Weltzien et al, 1996; Witcombe & Joshi, 1996). Farmers participating in PVS obtain a better access to finished breeding material. PVS on the one hand democratizes and on the other rationalizes release mechanisms*

*Beyond the Perspectives in Participatory Plant Breeding*

Participatory approaches in the seed and plant breeding sector are primarily developed with the efficiency and diversity perspectives on participation. Control in the planning, design and implementation are basically in the hands of researchers (de Boef *et al.*, 1996). Approaches strengthening farmers' experimentation in local crop development and elaborated in other sectors of development have hardly been employed at all in the institutional seed sector (Van der Heide *et al.*, 1996). Farmers' experimentation in the local seed system is no really recognized as a valid system for crop development by actors in the institutional seed system. The potentials for the development and improvement of the local system are underestimated, especially with regard to complex, diverse and risk-prone environments (de Boef *et al.*, forthcoming). Actors in the institutional seed system can link directly or through development organizations to this local system.

An integrated approach puts activities in the fields of conservation, breeding, multiplication and marketing into a different perspective. The function of the institutional system within the empowerment perspective on participation evolves from being a generator of technologies to a facilitator in the enhancement of the local system. Methodologies for empowering farmers in their research may coincide with those applied within the perspectives on participation aiming at increasing research efficiency and developing a diversity of materials and technologies. In this way, an increase in farmers' access to scientific knowledge (a.o. in selection procedures) and materials (a.o., germplasm, segregating populations, advanced lines and released varieties) can result from the different interactions. Activities such as strengthening decentralized seed production, processing, storage and exchange, and the support to small seed enterprise development are other elements of an integrated and empowering approach.

Participatory approaches in the institutional seed system have mainly developed in isolation from other similar activities and from the core (breeding) programs of the institutional seed system. Strengthening farmers' research in the local seed system requires cross-sectoral, interdisciplinary and integrated approaches. Activities such as the on-farm management of PGR can not take place in isolation from participatory plant breeding activities (de Boef *et al.*, forthcoming). The problems of agriculture in complex, diverse and risk-prone environments can not be solved by participatory programs implemented in isolated departments or projects of NARS or CG centers. Participatory research activities need to be integrated in the core programs of these organizations.

The different actors in the institutional seed system (NARS, CG institutes) and development organizations like NGOs play specific roles in an integrated seed system development of this kind. Acknowledging the specific roles of the different actors in such a development and recognizing the actors' different perspectives on participation are preconditions for fruitful collaboration in support of farmers' research in the local seed system. Methodologies can be developed or adapted within this collaboration. They will stimulate the development of integrated and participatory approaches to seed system development, by means of which a sustainable production and use of reproductive materials in complex, diverse and resource-poor agricultural systems can be supported.

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# METHODOLOGICAL CHALLENGES FOR INSTITUTIONALIZING PARTICIPATORY RESEARCH AND DEVELOPMENT

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The methodological challenges of institutionalizing participatory research and development (R &D) will be highly dependent on the "model" of participation adopted. The authors believe that participatory research has to be largely shaped, even controlled, by farmers and other stakeholders if the resource-poor are indeed to have more than a token voice in the international agricultural system. In addition, institutionalization ultimately means that the process will have to be scaled up. The paper below, including the key questions, reflect these perspectives.

Participatory R&D has some unique characteristics which will affect its institutionalization in the agricultural sector.

First, it is client-driven. This means that farmers'[6] knowledge, needs, criteria, and preferences have weight in decisions about technical innovation. It also, more fundamentally, implies that farmers are actively involved in decision making about innovation, not just at the very late point in time when adoption (or rejection) occurs, but early in the process when the agenda for research is set, when specific themes are proposed, and when design features are determined.

Client-driven agendas differ markedly from those geared toward basic, long-term research. Clients have differing needs, specific to their own agronomic and socioeconomic situation. Farmers, when themselves exploring management techniques or specific technical products have always done so in a given locality with particular constraints and opportunities in mind. Addressing client needs means that the R & D process itself must be sufficiently decentralized to meet diverse farmers' goals and to allow for site-specific, local adaptation. Such decentralized technology development suggests other features central to participatory R&D.

To anticipate diverse client needs, research has to develop a capacity to generate options or 'menus' not only 'on the shelves', but actually in the fields, watersheds, and woods. Research programs and regional experiment stations need no longer aim for final recommendations. Instead, to facilitate decentralized technology development, researchers and farmers need to work together early in the research process to develop 'prototype designs' which will then be

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5 This paper draws on two articles: Ashby and Sperling, 1995; and Sperling and Ashby, 1996.

6 For ease of reference, we will use the shorthand "farmers" to refer to a range of stakeholders involved in both agricultural and natural resource management.

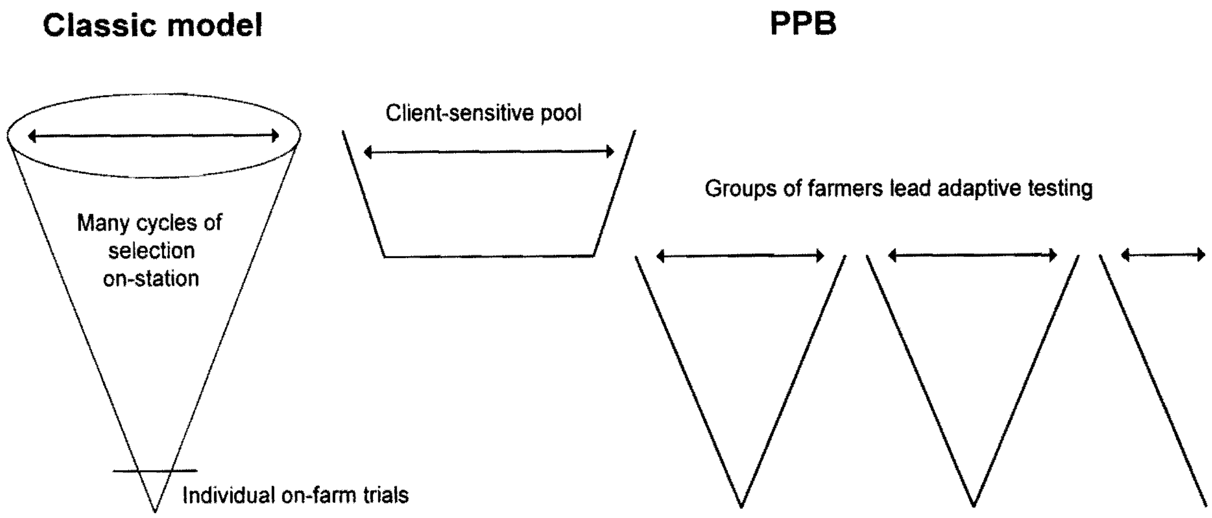
shaped or contextualized to fit specific client niches. This second feature of participatory research, the development of prototypes, rather than finished products, may start involving clients at a series of different early stages. To take an example from participatory plant breeding (PPB): farmers have been taught to more effectively handle crosses themselves (Kornegay *et al.*, 1996); they have been involved in screening segregating populations (Sthapit *et al.*, 1996 ); and farmers have been brought directly onto experimental stations (Sperling *et al.*, 1993) and onto farm sites (Weltzein *et al.*, 1996) set up for screening pre-released lines.

Effective decentralization of technology testing is a task beyond most public sector research services. Testing of many different 'menus' tailored to different preferences and localities sets the third major feature of participatory research: the shift to farmers of major responsibility for adaptive testing. Farmers take the lead in organizing experimentation, evaluating results, and transmitting local recommendations. Such a shift potentially allows for increased scale of testing, better targeting of varieties, and more realistic variety evaluation.

Is the participatory R & D framework really very different from classic farmer-sensitive research approaches? Figure 1, again focused on the breeding paradigm, suggests some important conceptual and practical differences. In the classic model, researchers make all major decisions on germplasm creation and promotion from the initial stages when germplasm choices are wide through the varietally-narrow stage of on-farm testing. Screening criteria, by necessity, focus on areas of breeder expertise: usually yield and adaptation in controlled experimental plots and sometimes tolerance to regionally-important diseases. Client feedback takes place right before varieties are to be released for diffusion--if it comes at all. At this on-farm stage, farmers' only option is to accept or reject some two or three finished cultivars. Finally, formal research most often works with individual farmers, with the notion that once the variety is "okayed" it can be multiplied and diffused by a separate seed and extension system.

As the figure below shows, a PPB approach enhances farmers rights', involvement, and responsibilities. The initial germplasm pool is directly shaped with strong client input. Screening criteria fan out to include farmers' quality concerns and local production requirements, e.g. a specific maturity cycle or plant architecture so as to fit varieties into multicropped systems. As farmers' screen or help develop a subsequent prototype pool, they are generally exposed to a more diverse range of germplasm and, to meet their different needs, the PPB screening format has to be decentralized to farmers very early on. This farmer leadership in adaptive can potentially shift some of the costs away from the formal research system, with farmers more effectively integrating select experimentation into their ongoing farm management practices. Group work, early in the technology development process usually also has important spin-offs: promising entries are multiplied and diffused with speed, variable entries are shifted to fit more appropriate production niches, and the losers are discarded with efficient speed. Finally, in a PPB system, it is clients who make the first cut selections, with researchers then adding (or not) the supporting blessing.

**Figure 1: Schema of classic breeding v. participatory breeding approaches**




The rest of this note poses some of the key methodological questions tied to institutionalizing these three facets of a participatory R & D approach.

## Client-Driven Agendas

In setting a client-driven agenda, one of the most commonly raised issues is how to reconcile the diverse, and often competing priorities and preferences of different client participants. Cattle ranchers will have different demands from nomadic pastoralists; women farmers have different priorities from men; commercial farmers differ from semisubsistence producers. A nightmarish vision could be painted of literally thousands of different demands for localized research 'menus' being articulated by participating farmers; and the question is posed 'how can research systems respond to this?' .

Two mechanisms have generally been proposed to increase client's influence on the research agenda. The concerns have been to give farmers a voice, but also to help resolve competing interests among the various groups of clients themselves.

One strategy suggested is to give farmers representation in the research arenas where decisions are continually being made: e.g. on the boards of national and international research institutes--or even on the Technical Advisory Committees. To do this, several options have been proposed: farmers could participate directly in planning exercises; researchers could act as proxies for farmers; or pre-planning meetings could be held in select farming communities with research priorities then fed back to the decision-making fora (Merrill-Sands and Collion, 1993). Within this model, research agendas would be negotiated within a centrally administered research system. Note that the issue of taking the client seriously still hinges to a large degree on researcher 'good will', with a substantial dose of interpretation as to clients' real wants/needs.

A different mechanism for determining whose research priorities are given weight is one which places a significant proportion of the available resources for financing research under client control. This approach removes the need for centralized research planning by creating the means for client groups to contract applied research and so exert demand-pull on the research system. There are many cases where wealthier or particularly export-oriented farmers in both developed and developing areas have been able to influence research budgets and effectively lobby for specific technologies (for the Netherlands, see Röling 1989, for Zimbabwe, see Biggs 1989, for South Africa, see Carney 1996). Poor farmers, however, and particularly those less market-oriented, organize less easily, have almost no financial leverage, and their real ability to say 'no' to a technology makes itself felt but erratically (Röling 1989b). A model for contracted research by resource-poor farmers is currently being tested in Mali, with the World Bank providing the "farmers' leverage money" (Collion, 1995).

What are the key methodological questions for institutionalizing the notion of client-driven agendas? In both the centralized and contract scenarios, clear policy guidelines are needed to ensure that the representation is neither token nor biased. Issues to be resolved: 1) how to identify which user groups are represented, or in the contract case, should get a chunk of the financial pie (those most important to economic growth? Those most needy? Those with the highest political profile?); 2) how to develop the capacity for client groups to express demand as aggregates rather than as individuals? and 3) how to improve the effectiveness of existing organizations to represent the range of client needs?

*Key Question:*

By what overall mechanisms/methodologies can participatory research become more "client-driven" (i.e. how can farmers be given a central voice in setting priorities at the local, regional, national and international levels?).

*Sub-question:*

On what methodological basis will client groups be chosen to participate in setting the agenda?

## Prototype Development

Rather than focusing on fine-tuning a limited number of products and then verifying them on selected sites, a prototype approach suggests that a number of options need to be developed in the early stages of R &D on which are then tested and may be modified to suit specific needs and circumstances. Such an orientation means that scientists working on experiment stations should have a relatively good idea of the broad range of client needs and constraints at the beginning of the technology development process. It also suggests that scientists have to be prepared to part with their technologies at a relatively earlier stage in their product development--before they have 'the' answer.

There are two central questions related to institutionalizing a prototype approach:

First, what are the most effective methods for getting farmers involved in R & D at the prototype stage? As prototype designs may not be finished, significant efforts may be needed to help clients conceptualize what the end product may be. In the case of varieties, farmers may have had direct experience with segregating populations and with extrapolating the performance of varieties from one environment to another. However, environmental prototypes are very different in that they are often knowledge-intensive and may have few physical manifestations in the early stages. In addressing this concern, some researchers report good experience with exposing farmers to general technological models, outlined verbally rather than physically (Sumberg and Okali, 1989). Are there other special methods which might help farmers project from early stage technology?

*Key Question:*

What are the most effective methods for getting farmers involved in R & D at the prototype stage?

Second, are there added risks of involving farmers at the prototype stage?. As an example, much of the debate on prototype screening in plant breeding has focused on projected negative consequences of early involvement, and, specifically, early access to varietal material, and increased risks. Fears expressed are wide-ranging: disease incidence will rise; yields will decline; farmers will lose confidence in Research; farmers will receive materials that are no longer uniform...,and so on. In thinking about prototype approaches, researchers have to ask first if these concerns are valid ones, and, if so, reflect on how they might be mitigated, that is, develop methods to proactively anticipate possible new risks.

*Key Question:*

Are there added risks in involving farmers in prototype design? If so, what conscious research strategies and methods can minimize these risks?

One of the challenges of prototype screening is to find the most efficient "intellectual" division of labor between scientists and farmers and clarifying their respective roles will be key. In many contexts, their comparative advantage may lie principally in screening 'exotic' options and anticipating 'dangers' that farmers cannot 'see'. For example, in selecting germplasm, scientists might screen for disease-susceptible or anti-nutritional genetic traits which may not be immediately apparent to farmers. Farmers would then take the lead for all other factors, including targeting varieties to environments. Certainly a related goal of prototype-focused programs should be to identify the stage in prototype screening which is most cost-effective. For example, if screening of stabilized varieties brings significant results to a range of farmers, it may not be necessary to push the direct collaboration to earlier developmental stages.

What might be the parallel divisions of labor for natural resource management (NRM) technologies? Will the scientist and farmer responsibilities differ by the type of technology? Will they differ by the scale needed to achieve results? Will the division be shaped by the time horizons required to achieve results? The issue of prototype (preadaptive) screening in NRM is still very much at an incipient stage.

## Implications of Farmers Taking the Lead in Adaptive Testing

Institutionalizing farmer participation involves developing a community-based adaptive research capacity, achieved by working with groups of farmers (rather than individuals) and often with producer organizations. While the participation of farmer groups in localized R & D facilitates farmer-to-farmer training and rapid transfer of information about innovations, it also presents a series of challenges.

For national and international agricultural institutions, the fundamental question surrounding farmers' role in adaptive research is the quality of testing achievable with farmer participation. When farmers are involved in trial design and management, data sets can be heterogeneous within and among locations -- although such results may be realistic of actual farming practices. Should participating farmers be encouraged to standardize their own designs? Should farmers be taught to internalize and manage western scientific methods? Following this latter logic, farmers, independently, could generate locally reliable and adoptable recommendations. The costs and pay-offs of different approaches need to be addressed empirically (see Ashby, 1986). Is there a trade-off between standardization and stimulating local creativity? Is there a trade-off between standardization (or lack of) and interpretability? -- and for whom?

*Key Question:*

What is the quality of data possible with farmer participation and what might be the trade-offs of adopting controlled v. freer research paradigms?

A second concern focuses on which type of groups to work with in adaptive testing: that is, if farmers are to take the lead, how should adaptive testing be organized? The research system, in order to met its own responsibilities, certainly would have a wish list of traits for its partners. Minimally, local partner organizations would represent the clients research feels it needs to reach, and such local groups would work on a scale which allows for results to be extrapolated. To meet such basic criteria, should research look to work systematically with already existing groups, such as non-governmental organizations (NGOs), farmers' organizations (FOs) or indigenous community units? Or, as an alternative approach, partially to ensure research rigor, should scientists catalyze the development of 'farmer research groups' (e.g. the CIALs case, Ashby *et al.* 1995). What are the trade-offs of different organizational approaches in terms of attaining representativeness, usable research results, defraying immediate costs and encouraging sustainability of the partnership?

*Key Question:*

What are the options for organizing adaptive testing with groups of farmers to meet both farmers' and researchers' aims cost-effectively? For instance, are there trade-offs between representativeness and research rigor? Might there be strategies to minimize inevitable biases?

**Support Services to Move Outputs of Participatory Research**

On a final note: client-driven programs centered on prototype screening and delivering site-specific options will demand a reorientation in the support services of research. Decentralization of technology development has implications for the structure of related delivery systems, such as credit, extension and seed multiplication services. Research is needed to identify the organizational structures and the type of human resources required to accommodate participatory R&D. New partnerships may have to be forged with local level groups or intermediaries such as NGOs to take on the heightened demands of a more targeted support sector. Finally, formal extension itself, particularly in terms of knowledge-intensive technologies, may have to fill new roles: supporting farmers' own capacity to adapt site-specific solutions from one locale to another.

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# FARMER PARTICIPATORY RESEARCH: MEASURING IMPACT

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The major issues in impact assessment for farmer participatory research are: determining the reasons for measuring impact; the people who will measure it; the products or processes to be measured; and the methods used for measurement. We measure impact first to know if the activity is worth the effort involved. Once that has been ascertained, we want to know if we are operating in the most efficient manner possible—is there a better way?

In the case of FPR, there are many potential ways in which it can have an impact. For example, FPR may increase agricultural productivity, improve the management of natural resources, or lead to a wider dissemination of innovations. FPR may also be more effective in reaching specific target groups, and it may reduce research costs and develop community capacity. All of these ultimately improve human welfare. FPR may not achieve all of these objectives in all cases. The researcher conducting impact assessment must decide which of the outcomes of FPR are worth measuring in any specific case.

According to the circumstances, impact will be measured by different groups, and for different reasons. FPR practitioners will want to evaluate their strategies to determine when farmer participatory research works, and how. Farmers will evaluate to decide if the research is truly serving them. Policy makers must ascertain whether projects in participatory research are worth their investment.

When the time comes to carry out an impact study, the assessors face a number of decisions. The first is: what to measure? As noted above, FPR may yield a variety of outputs, or intermediate outputs followed by the final results. The impact chosen will depend on the motive for the evaluation: the evaluators will take into account the objective of the FPR intervention and also their own intentions for the study. An effort to improve FPR techniques will result in a different focus than would a review of the effectiveness of specific agricultural innovations.

Depending on the output chosen, the researchers will then determine how to measure it, selecting an indicator that will accurately assess the progress made. The progress will be measured against a baseline, comparing the situation either in terms of time—comparing a situation both before and after the research was done—or comparing a situation with improved conditions against the situation without that improvement.

At this point in the assessment, researchers must ensure comparability of factors, avoiding comparisons of factors or conditions that are not truly related. They must also take into account factors that might intervene and prevent a true evaluation. For example, a drought or civil problems could interrupt successful completion of the research or technology adoption.
A primary output to be measured would be the monetary benefits accrueing to the farmers from the results of the research. Other important outcomes are increased community capacity, improved nutrition, or greater benefits to specific target groups. It is not always possible or practicable to assess the final outcome, either because of the long research lag, or because of the delay in adoption or in the onset of benefits. In these cases, the researchers can measure progress indicators or intermediate outcomes.

In a typical case applying FPR to increase productivity through technical change, initial outputs could include types of technology, which might encompass new varieties of germplasm, or methodologies for integrated pest management, crop management, or post harvest. But the ultimate outputs would be the results of applying these improvements, manifested in increased yields, reduced production costs, greater stability, or improved sustainability.

It's important at this point to distinguish between the different types of FPR. Many people consider FPR to be the process of introducing existing technologies to farmers to try them on their farms. This "adaptive" FPR occurs at the end of the research process; it is an advanced form of extension. "Preadaptive" FPR comes early in the research process, and makes it possible to better identify farmers' needs, and from there to elaborate a research program to meet those needs.

Preadaptive FPR results in improved technology design. This, in turn, can have the consequence of producing impacts more rapidly, - or impacts that are larger; or impacts that reach more people. Intermediate results of preadaptive FPR include a better diagnosis of problems or constraints, better results from trials, and changes in the research agenda.

One of the objectives of FPR, improving resource management, tends to be a broad area that affects many people and can be complicated to measure. Better resource management can, for example, improve or protect soils, water, or biodiversity. It affects resources both on farms and beyond them, and means many things to many different people. The smallholders at 2,000 m will have a very different relationship with their water supply than will urban dwellers, but a project to protect water supply at 2,000 m can affect users at many levels. This may make measuring impact much more difficult. The time frame can also be more complex when evaluating resource management projects, as some have a very long-term impact.

Types of impact to be measured may include enhanced diffusion, measured in terms of increased rapidity, spatial distribution, or diversity of users. It's important to ascertain that the technologies are reaching the people who need them: especially those without other resources, women, ethnic groups, or people in marginal areas.

Another impact to be measured is the reduction of costs to the public sector. Traditional on-farm research requires an enormous amount of monitoring by scientists and technicians. Efficient FPR can replace much station research, thereby reducing costs. It also places a lot of the research procedure in the farmers' hands, which relieves the work load on scientists and field workers; this is a way of sharing costs, although the farmers contribute through their efforts rather than financially.

A final impact to keep in mind is the development of community skills: social capital. As the farmers learn and take over the research procedure, the impetus passes into their hands. Also, indigenous research capacity is improved. As farmers set their own research agendas, the NARS become service providers. Institutions that follow the needs of the farmers are more likely to have vital and sustainable programs.

A final consideration for the FPR developer or researcher: planning an impact study. Such studies may just address the specific results of a particular project, which is obviously necessary for evaluating the project's results. But it would be more important for a systemwide program to study the actual dynamics of the FPR process, in order to arrive at an ever-better understanding of which methods and processes work in which circumstances and for which purposes.

# SCALING UP PARTICIPATORY RESEARCH

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## Introduction

'Scaling up' is an ill-defined term which tends to convey distinct and dissimilar impressions to different people. Its essence is that it is **increasing** the successful elements of a project or a programme, but whether this is increasing depth or breadth of efforts, or a combination of the two, is often unspecified.

## The Purpose of Participation

In order to clarify this issue, we have - briefly - to go one step back and think about the purpose of participation. The proposal to the TAC submitted by CIAT/CIMMYT/IRRI details the functional or efficiency benefits of participation (better technologies, more widely adopted, more quickly). For others, the main objective of participation is to empower marginalized people and groups so that they can make claims on others (whether research and extension organizations, sanitation departments etc.). The two are not mutually exclusive; functional participation can be empowering, and empowering participation may lead to functional efficiency gains in technology development. However, the two do imply different spending priorities and time horizons, the quest for empowerment generally demanding more intensive participation over a longer time period than the quest for functional efficiency gains in a particular area. They also imply different indicators for project monitoring.

For present purposes, let us assume that we are dealing primarily with functional participation of which the empowerment of client groups is a valuable and perhaps deliberate corollary. The purpose of the participation is then to increase the ratio between the benefits and the costs of spending on agricultural research or rural development more broadly. For a given amount of expenditure (the amount being politically determined if in the public sector or determined by the effectiveness of fund raising and internal priority setting if conducted through NGOs), participation is expected to generate greater benefits than would a non-participatory approach. Participation itself may be very expensive but (at least if it is valued on a functional basis) it must also be cost-effective both for the financing agency and for those who are participating.

## What Is It We Are Scaling Up?

The second issue which must be clarified is what exactly we are aiming to scale up. Is it the results of the process of participatory technology development? Or is it the methodology for participatory technology development itself? Both are feasible.

### *Scaling Up a Technology*

If a particular variety has been developed in a participatory fashion, one version of scaling up would be to seek other areas with similar needs which would find the variety acceptable (even optimal, if the similarity is very great). If such an area were to be identified, the benefits generated by a given investment would grow.

In plant breeding this task may be done for us, assuming that phytosanitary barriers do not get in the way (e.g. if exchange is cross border) and that local distribution channels (either market or exchange driven) are adequate. Planting material can be moved, exchanged and experimented with at relatively low cost and with little labor investment. This is less true for NRM technologies. Soil conservation techniques, for example, can generally not travel independently of key, well-informed individuals[7] (either the farmers who are utilizing them or supporting extensionists or project staff) and even where they do travel as `finished products' (rather than as ideas which require further participatory, adaptive research) they may be greeted with scepticism. This is because they tend to be labor intensive and often to require group action to reap the full benefits, which themselves may not be observable over the short term. Participation in NRM tends therefore to be less oriented towards pure technology development and more oriented towards demonstrating benefits in order to ensure adoption. Unplanned scaling up of such technologies is therefore more rare.

If technologies developed through farmer participation are to be deliberately scaled up, we need to develop a method to help us determine when and in which areas this is likely to be possible and beneficial. We must seek critical biophysical and socioeconomic indicators of `adequate similarity', where adequate similarity' is the minimum level of similarity that must be achieved if replication of technologies themselves, rather than a repetition of the participatory process of technology development, is to be cost effective. It must be acknowledged up front that such indicators are most likely to be satisfied in relatively better-off areas which can be unified through the use of fertilizers and irrigation and where residents have some capacity for investment.

If they are to be successful, these critical indicators must be developed in conjunction with the `prototype' technology itself, drawing on the information gathered during the participatory process. Information relating to their achievement might then be gathered through use of GIS

7 Increased literacy, printed matter and broadcast communications can change this.

imaging, targeted surveys or by drawing on existing work of other agencies (for example NGOs working in the area). We also need to monitor patterns of adoption in successively more different areas (or with successively more different farmers) to ensure that we have both selected the right indicators and defined 'àdequate similarity' neither too broadly nor too narrowly. Finally, we need to accept that this is a short cut which we are willing, or which limited budgets make it necessary for us, to take. Usually the preferable option - and probably the only option for the poorer, more complex and more risk-prone areas - is to engage in deep participatory exercises with all communities to ensure that we are offering optimal technologies. However, this is often simply not feasible.

*Scaling Up a Methodology*

If there were no limit on funds available, the preferable option would be to scale up the methodology itself, to increase the number of times that the participatory and gender-sensitive research exercises are conducted so that better technologies could be developed. Indeed, one question to be addressed is how we are able to determine when it is more appropriate to scale up a technology and when it is more appropriate to scale up the methodology.

**Demonstrating the benefits of participation.** If the decision is to scale up the methodology and if scaling up is to be significant (ie. if much participatory research is to be conducted), there may exist a prior stage in which decision makers must be `converted' or `won over' to the benefits of participation. This is a question of changing attitudes. During this stage the benefits of participation must be clearly demonstrated. This is easier in some areas than in others. In plant breeding, for example, the benefits of participation are relatively easily measured over the short to medium term (rates of adoption, yields etc.). The benefits of many NRM technologies are by contrast hard to measure (whether they involve participation or not), and certainly so over the short to medium term. However, if budgets for participatory research are to be maintained, this is not a challenge which can be avoided. More effort therefore needs to be put into measurement and recording of costs and benefits as a core dimension of methodology development itself.

**Designing methodologies with a view to scaling up.** In its extreme form, scaling up the participatory methodology implies that participation becomes the normal frame of reference; we end up talking not about distinct participatory exercises, punctuated by periodic returns to the `old style' of research, but a continuing dialogue between scientists and their clients. Further developments are required if this point is to be reached. In particular, participatory approaches must be designed with a view to scaling up.

Neglect of the need to analyze costs and benefits, coupled with a desire on the part of some donors and NGOs to sponsor an ever more `perfect' participatory exercise, has led to a situation in which many efforts at participation are so resource-intensive that they are never even notionally amenable to scaling up. This tendency is exacerbated by the fact that, while relatively well-resourced NGOs and donors frequently pioneer participatory approaches, it is usually the severely resource-constrained public sector which is called upon to take responsibility for scaling up. The frame of reference in investment decision making thus changes part-way through the process of scaling up.

The critical change, if scaling up of methodology is to be achieved, is that all agencies involved should recognise that this is a valid goal and should be prepared to modify their approaches accordingly. `Best practice' should be based not on the methodology for the most intensive individual participatory research exercise, but on examples which are replicable or institutionalizable on a wide scale. While `cutting edge' research into participatory methods should still continue, it, too, should be conducted with an eye to expanding the scale over the longer term.

If NGOs are to conduct this type of research, they need to understand what it takes to scale things up, in which case they need to put far more effort into understanding the way in which the public sector - or the rest of the agricultural technology system - functions, and the constraints under which it operates. For its part, the public sector needs to open itself up to scrutiny and to acknowledge the value of developing partnerships with NGOs as a mechanism for seeking both depth and breadth in participation.

## What Benefits Does Scaling Up Bring?

The overall objective in scaling up is to increase the benefit:cost ratio associated with investment in agricultural technology development. Fortunately, whether we are scaling up products or methodologies, there are two forces at work which help us to do this: the propensity to move upwards along the learning curve (learning by doing) and the related existence of economies of scale. If we make deliberate efforts to nurture these forces, our benefit:cost ratio is likely to rise more rapidly.

### *Learning Curve Benefits*

These occur when the same final product is produced more effectively because of cumulative experience in production. This is a slightly complex concept when talking about participatory technology development, because, by definition, the product (ie. the technology itself) is unknown at the beginning of the research process and two products (i.e. technologies developed in a participatory way) are rarely the same. However, if we recognize this fact and focus on the methodology, it is logical that the skills of those implementing it should increase with cumulative experience. Indeed, learning curves tend to be steeper when initial skill requirements are high, but few implementers have the skills at the outset. This is certainly the case in social mobilization for participatory research. Indeed, lack of trained researchers has been one of the major constraints on the expansion of participatory approaches. Therefore as researchers gain experience (first as implementers and then as trainers) the ratio of benefits:costs in participation should increase. This increase will be magnified if similar learning takes place in developing critical indicators for `adequate similarity' so that scope for exploiting economies of scale relating to the technology itself expands.

*Economies of Scale*

Economies of scale occur when the *same* product/methodology is produced/enacted on a larger scale. They are usually associated with high fixed costs of production. Therefore, on the product or technology output side they would be expected to be large (given the large initial investment in participation), if further areas in which the technology is applicable can be identified. If thousands of hectares are planted to a new variety, the development cost per hectare is far lower than if just a few hectares are grown. Indeed, it is because of this that participation (to ensure that thousands rather than tens of hectares are planted) is espoused in the first place. Expansion in the initial investment costs is desirable if the payback is sufficiently large.

Participatory technology development is a people-intensive (rather than hardware intensive) process. This means that on the methodology side there are few economies of scale to be captured. The length of time required for participation does not usually fall with successive experiments and the number of hours an individual can work in a day does not rise. Learning is important, but that has been covered in the previous section.

## Product Development

While economies of scale might be more evident on the technology side, `product development' has, paradoxically, more scope on the methodology side. This is because in participatory technology development the product or output technology is unknown at the outset.[8] It cannot be `developed' in isolation from the methodology. Rather, improvements in methodology should in turn generate a better product or technology. While in industrial research and development investment is made in both product development and process development, in participatory research only process development is viable. If however, we take the methodology itself to be an intermediate product (as we have done here), then the nature of product development becomes clear. It occurs when a methodology is honed through successive replications or feedback from performance monitoring.

This suggests, however, a linear trajectory in methodology development which is certainly not what we should be aiming for. The objective is not to find a single blueprint methodology for participatory research. Even makers of commercial products espouse different engineering processes. Indeed, competition between different manufacturers with different products and

[8] This is something of a caricature since, especially in NRM, researchers rarely start with a blank slate. They often have known technologies in mind which they then adapt through participation, subsequently feeding improvements back to modify the initial technology.

processes leads to innovation. While competition has little place in the world in which we are working (although it is certainly observable), it remains desirable to experiment concurrently with a variety of different approaches to participation so that comparisons can be made and elements of each can be drawn upon.

*Spillovers*

In economic terms this is known as 'learning with spillovers'; the benefits of learning spill over and are shared. It is these spillovers which we should be trying to capture if our learning process about participatory methodologies is to be accelerated. While learning in this manner is necessarily fragmented, our learning about participatory research methodologies is probably too fragmented at present. Insufficient information exchange about methodology development (failures as well as successes) takes place and too few spillovers are being captured. Indeed, one reason why we have come to this seminar is to rectify this. Just as there may be certain industry standards for manufacturing in relatively mature industries, so we should be looking for common ground in methodology for farmer participation (since participatory research methodologies are now achieving a degree of maturity).

This is not to say that all ground will be common, for by the very nature of participation, the methodology for any single participatory research program must be adapted to suit local circumstances. However, we might envisage and work towards a list of common features - a good practice guide with wide applicability - which can be coupled with lists of variations and permutations as well as indicators as to where these are likely to apply. This list, too, would develop, but in the meantime it would provide an anchor for our learning, which should, if it is to be effective, be focused on particular areas. In particular, expanding the breadth and the depth of participation.

*Seeking Ways To Ensure That More People Participate*

Given the diversity and complexity of rural people's needs, the more people who are drawn into the research process, the better the results should be.[9] However, the danger is that an expansion in numbers participating leads to a reduction in quality of participation or a linear (possible exponential if poorer people are to be reached) increase in costs. This is where groups are assumed to have a lot to offer: if groups can act as intermediaries and take on some of the costs of communication with members, then they can generate efficiency savings in the process of participation.

Over the past decade, much hope has been pinned on formally constituted farmers' organizations or unions as potential intermediaries in the technology development process. They are assumed to have direct, 'insider' access to members which gives them intimate

9 Although the fact that a research system cannot respond to infinite variability in demand probably means that the increase in benefit per person consulted becomes successively smaller after a certain minimum number of people have been consulted.

knowledge of members' needs and preferences. This knowledge is then pooled, prioritized and presented to other technology suppliers (either in discrete partnerships or at the level of technology policy development). In this way formal farmers' organizations are expected both to increase the efficiency of the technology development process and to raise the `voice' of farmers in the agricultural technology system.

Research conducted by ODI (with ISNAR at the outset) over the past two years indicates that our expectations of such formal farmers' organizations have probably been too high. Weak internal communications and a lack of emphasis on technology mean that they are rarely able (or willing) to speak with legitimacy for their members on technology matters. While they might be able to bring general attention to the fact that members' needs are unmet, large, formal farmers' organizations are seldom the best partners for intensive, adaptive research partnerships. Furthermore, they often neglect the needs of their poorest members and have done little to increase the lateral spread of technology or research skills between members. While some express an interest in becoming involved in the technology area, few other than those which are directly involved in marketing members' produce (and which are therefore able to prioritize by reference to the market), have the capacity or resources to do so.

When we are thinking about `best practice', more thought therefore needs to be put into this area. Groups are not the magic solution we had wished for, yet, too often, they are still treated as such for want of better ideas. We therefore need methods to help us to distinguish which types of groups are appropriate for which types of task. Support and capacity building is also likley to be an important area of work.

*Increasing the Intensity of Participation*

Another option is that, rather than increasing the number of people who participate, we focus on increasing the intensity of participation. Arguably, if clients participate earlier on in the technology development process, then the scale impact of their participation will be greater. Thus if a given farmer, or group of farmers, participates in technology priority setting, the overall impact - in terms of capturing the benefits of client orientation - will be far greater than if the same farmer or group of farmers participate in the final stages of adaptive research. Similar benefits might be captured if farmers were drawn in to evaluation (an area of participation which has been relatively neglected), which would then feed back into project or program design. Up to the present, participatory methodologies have focused almost exclusively on needs diagnosis and downstream research areas.

However, extending participation to the priority-setting phase has been tried in some places, for example with research users' groups in Mali and in the sugar industry in South Africa. The results so far have been modest; few changes in priorities have been observed. This may be because the research agenda is fully satisfactory, but this seems unlikely. A variety of other reasons can be identified. First, technology priority setting as a whole is poorly understood, by long-time as well as new participants. This makes changes hard to bring about. Second, this is perhaps the area in which scientists and clients are most likely to find that they have irreconcilable differences and where conflicts over the relative allocation to short-term vs. long-term research are the most common. Mechanisms for resolving these conflicts have not been developed. Third, those who are being asked to participate may not be fully aware of the options available or the potential scope for change which science offers (if they have never benefited from technology themselves, this is hardly surprising). Fourth, much priority-setting is based on precedent and, by the time participation is invited, key budget allocations have already been made.

Significant capacity building (through participation in the first instance in smaller-scale technology initiatives, and familiarization with the research system as a whole) is likely to be required before the full benefits of participation in priority setting are likely to be reaped. The danger that should be avoided is that early participation by farmer representatives is ineffectual but means that the *potential future* contribution that farmers can make is discounted.

Other, perhaps more successful, ways of increasing the intensity of participation include finding ways to change the incentives to participate so that earlier participation makes sense. Notable in this area are schemes to compensate farmers for the risks they take in participating in technology development. This is another area in which we need to pool our experience and develop guidelines for best practice.

## Broader Considerations: Policy and Politics

Although we may try to avoid it, we are dealing in our discussion with inherently political issues. In particular, national priorities feed down into research priorities and overall budget allocations are usually made at the political level. In principle, one way of achieving wide-scale impact is to work through political bodies rather than to restrict the focus to line departments and members of the agricultural technology system itself. If political bodies - which are notionally fully participative through the electoral process - can be persuaded to put their support behind participation as an overall policy, then scaling up is likely to be a less arduous process.

Political support can change the environment for participation. It can make line departments answerable to decentralized political bodies for their funding, giving the population as a whole (dominated though it might be by elites) a far greater say over activities. It can also put in motion changes in incentives in the public sector so that rewards are based on indicators of participatory research rather than exclusively academic excellence. Finally, it can mean that policy is formulated in a participatory manner. If information gathered in participatory research exercises gains credibility (through political support) then it is more likely to be used, albeit with some necessary abstraction, in policy formulation. This policy, in turn, will have a vital enabling (or disabling) influence on the practice of participatory research.

## How To Move Forward

From these many and complex issues I wish to raise the following key questions for further consideration:

*Scaling up technologies:* How can progress be made in developing critical indicators for `adequate similarity'? This includes reaching some consensus on the minimum benefit:cost ratio we wish to achieve with participatory research.

*Scaling up methodologies:* What does it mean to develop a prototype methodology with a view to `scaling up'? How should we adapt our indicators to take this into consideration?

*Increasing the number of people who participate:* How do we move forward in working with groups or supporting them to help us achieve the efficiency benefits we are seeking in participation? In particular, how can we assist them to prioritize members' diverse needs?

*Focusing on the policy aspects of participation:* What scope is there for working with political bodies to ensure that research is progressed in a participatory manner? How much of a problem is elite dominance likely to be (and how distinct are the needs of the elites from those of the masses) if greater alignment with the political process is sought?

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# PARTICIPATORY PLANT BREEDING IN CROSS-POLLINATED CROPS: METHODOLOGICAL ISSUES FOR FUTURE RESEARCH

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## Introduction

The benefits from farmer participation in breeding cross-pollinated crops have been the focus of even less a Hentian than self -pollinated crops, possibly because most of these breeding efforts are geared towards breeding hybrids where the opportunities for farmer involvement are less obvious. In planning and targeting participatory breeding projects for cross-pollinated crops, it is crucial to envisage what role the newly generated genetic material may have in the local system of variety use, seed production and seed availability. Will the new variety be used in mixtures with existing varieties? Is there any local capacity to maintain the purity of specific varieties? Or will new varieties serve as a source of new genetic variation within the traditional system of seed selection and seed management. Better understanding of these issues will help to identify specific steps in a variety-development program which would benefit from farmer participation. Furthermore, a better understanding of the local seed management system will facilitate the linkage of the participatory breeding efforts with the local system of seed production and dissemination.

## Understanding Local Systems of Seed Management

Local systems of seed management in many parts of the world, and for many crops, are very poorly understood (van der Heide and Tripp, 1996) and plant breeding efforts have thus far rarely been designed to address the identified needs of such local systems. Generally, plant breeding programs are oriented towards the replacement of local varieties, with the implicit assumption that the local systems of seed management will also be replaced by regulatory frameworks and commercial seed enterprises. Farmer participatory breeding, in contrast, provides opportunities for integrating scientifically based plant breeding efforts with the farmers' reality. In order too facilitate this integration, it is necessary for farmers and scientists to communicate effectively.

Communication between scientists and farmers presents challenges that are rooted in cultural differences. These differences affect the applicability of terminology used by the scientists to analyze situations, as well as the ability of scientists to fully understand and interpret farmers' concepts and explanations. Communication tools that help to visualize the outcomes of discussions of farmers with scientists are an effective approach in overcoming these barriers to effective communication, especially in the case of oral cultures. The development of such communication tools has attracted a great deal of interest in recent years, and these have been widely adopted in rural development projects as well as in research: RRA, PRA, simulation exercises, etc. (Chambers *et al.* 1989; Gabathuler, 1991; Scoones and Thompson, 1994). There is therefore plenty of scope for the further development of such communication tools on this basis, focusing on an improved understanding of local systems of seed management, and on experiences with similar communication tools in other fields of research and technology development. New communication tools may target approaches to understanding farmers' concepts of a variety, farmers' strategies for the selection, processing and storage of seed, or the traditional channels for, and barriers to, seed exchange.

## Options for Sharing Responsibilities

The effects and the effectiveness of sharing responsibilities between farmers and scientists in the process of plant breeding have rarely been explored, especially in the case of cross-pollinated crops. Farmers' participation in the process of variety development has been proposed for every step in this process, ranging from generating variability to the testing of finished experimental varieties (Sperling, 1996, Weltzien *et al.* 1996; Witcombe and Joshi. 1996). The most important issue in developing and testing breeding methodology for cross-pollinated crops is to identify those stages in the breeding cycle during which farmers' participation would lead to the development of more acceptable and appropriate varieties in a shorter time, with a shortened timelag for initial adoption. Breeding methodologies that rely on farmers' comparative advantages in fulfilling specific objectives of the breeding cycle need to be developed and tested, so that the effects of sharing specific responsibilities, and the effectiveness of this compared to non-participatory approaches can be quantified.

Evidence from pearl millet in northwestern India (Weltzien *et al.*, 1997), and from maize in central America (Louette and Smale, 1996) suggests that farmers are actively seeking the diversification of their seed stocks, as well as the improvement of specific traits related to productivity, yield stability and quality. These findings support the notion that there is scope for sharing responsibilities between scientists and farmers in the initial stages of variety development and the generation of new variability as well as in the later stages of the selection and testing of experimental varieties.

For cross-pollinated crops, where outcrossing occurs naturally, a role for farmers could be envisaged in the generation of new variability as a basis for further genetic improvements. It may be worthwhile considering using population crosses and random matings initiated by farmers by mixing seeds of two different varieties and growing them in their fields. Potential benefits from the extent of recombination and the effectiveness of selection could be obtained under farmers' field conditions with the very large population sizes, and therefore, with high selection intensities for traits and trait combinations most preferred by farmers. Natural selection would help to eliminate genotypes unadapted to the most severe stress factors. This could be more efficient than making similar population crosses under non-representative, frequently off-season conditions, and with severe limitations on the number of plants that can be handled per population cross. Breeders could then use these farmer-generated population crosses for the targeted improvement of specific traits, which farmers cannot easily select for on a single-plant basis (e.g. grain yield, stover yield or disease resistance) without having to spend a great deal of effort on selection for yield components and adaptive or quality traits.

The primary role of the breeder in this process would initially become one of making useful new source material available to farmers for use as the parents of new population crosses with their own local varieties. For farmer-breeder interactions to be successful at this stage of the breeding cycle, farmers would need to be involved in evaluating a much larger range of material and genetic variability. It would also be beneficial if there was a better understanding of the combining ability of farmers' local cultivars with other sources of germplasm that farmers may want to use. Later on, the role of breeders would be to ensure that these new population crosses achieved desirable levels of performance for key traits, like productivity or disease resistance.

Similarly, it could be envisaged that farmers would take on some of the responsibility for the improvement of existing established populations, e.g. by mass selection in farmers' fields. Mass selection is an effective method of improving the local adaptation of breeding populations (Rattunde *et al.* 1989). The main advantage of mass selection is the high selection intensity that can be applied. Under farmers' field conditions, this advantage could be more fully exploited than frequently happens in research stations. In merging the farmers' experiences with selection for specific traits with the scientists' understanding of the biological and agronomic significance of these traits and their inheritance and interaction with each other and with the environmental conditions, progress from a mass selection program could be significantly enhanced. In this context, one specific methodological issue will need to be studied: how the frequently strong seasonal variations in the growing conditions and the effects of these on the population improvement process can be addressed so as to arrive at a balanced adaptation across a wide range of growing conditions over years and, hopefully, a wide range of locations. Farmers' experiences with different plant types, and their adaptation to specific growing conditions could provide insights here as well as the initial hypotheses for this kind of analysis (van Oosterom *et al.* 1996).

In specific cases, it may be possible to involve farmers in progeny-based selection procedures for population improvement. In situations where hand planting is common, progeny trials could possibly be conducted in farmers' fields, and evaluated by farmers or farmer groups as well as by scientists. Farmers could also assist with selection in progeny trials conducted on-station.

Thus, for cross-pollinated crops, a wide range of options and degrees of participation by farmers in the process of variety development appears possible, and could be meaningful. Carefully planned research is needed to clarify the benefits of the various degrees and types of farmer participation in this process in order to achieve increased productivity and yield stability, particularly for poor farmers. The role of women in this process needs to be investigated, because, in many cultures and for many crops, women bear the main responsibility for seed management and grain storage, as well as providing food for the family. Thus, working with women directly on these issues may open up new avenues for research on crop improvement and its impact on the food security of the rural poor.

To date, there are only a few examples reported in the literature where gains in efficiency for the variety development process could be attributed to the participation of farmers (Sperling *et al.* 1993). Part of this problem is that variety development programs are rarely evaluated directly for the usefulness of the new varieties to farmers (Ashby and Sperling, 1995). The most common indirect evaluation criteria are numbers of released varieties, or area cultivated with varieties from a specific program. These indicators have long time lags, and thus are not expected to be available from any comparative studies initiated recently. Therefore, research aimed at evaluating obtained benefits from farmers' participation in the process of variety development may need to develop other types of indicators for success. Thus, while the most important methodological issue is to actually develop effective models for participatory breeding approaches for cross-pollinated crops, methods for overcoming specific constraints and measuring impact are closely interlinked with this methodology development process.

## Linkages between Variety Development and Seed Production

The success of participatory approaches to plant breeding ultimately depends on linking these to seed production and dissemination systems. For cross-pollinated crops, this linkage to a locally appropriate seed system is particularly important, because special efforts will be required to maintain the identity and purity of products from any type of breeding effort. The formal seed sector can fulfill this role effectively in many cases. Thus, linkages between participatory breeding and the formal seed sector need to be explored fully whenever there is an opportunity. However, in many conditions, i.e with many of the subsistence-oriented, marginal production systems, the local system of seed production and distribution will be the only basis for making the new varieties bred with farmers' participation more widely available. This may require the development of new institutional forms, so that traditional channels of seed distribution can be fully exploited and barriers to seed movement overcome.

On this basis, three main areas for methodology development for effective participatory breeding programs for cross-pollinated crops have been identified:

1. Development of communication tools to understand the local systems of seed management.
2. Development of approaches for effectively sharing responsibilities in the process of breeding open-pollinated varieties of cross-pollinated crops.

3. Development of institutional mechanisms and linkages to disseminate these new genetic materials effectively.

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# METHODOLOGY DEVELOPMENT ISSUES FOR PARTICIPATORY PLANT BREEDING OF ROOT AND TUBER CROPS

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## Introduction

Root and tuber crops are the most important group of species propagated through vegetative means, and for which `several Centers in the CG have responsibility for germplasm development and diffusion. From the breeding point of view, vegetative propagation provides the advantage of immediate fixation of desirable heterozygous gene combinations, without the need to get involved in the development of inbred lines and commercial hybrids. The main disadvantage of this type of species is that, by using cuttings for propagation, the transmission of pests and diseases is facilitated from one crop cycle to the following. This results in the end in the "degeneration" of landrace cultivars, and their imminent disappearance in the medium to long term.

With the exception of potatoes, where several improved varieties from developed countries are cultivated over large areas in the world, farmers have been responsible for developing the genetic base which supports root and tuber crop cultivation. Improved materials produced from the recombination of germplasm accessions held by the international centers or the most advanced National Programs in the tropics have only recently been released and are now spreading. The majority of the root and tuber crops are used for human consumption, either directly or after some form of processing. Animal feed and industrial uses of root and tuber crops have been promoted more recently. This means that any new genotype that is released for cultivation must have an arrangement of traits that are desirable both for the farmers who produce the crop, as well as for the people who are going to consume it (most of the time these two groups coincide).

Most of the international and national program efforts for breeding root and tuber crops focused on a top-down green-revolution approach, concentrating on the enhancement of root-yield potential and the resistance to the main biotic and abiotic factors. Later, it was realized that production was not the only bottle neck for farmers and marketing was just as important. Therefore, our programs concentrated on devising alternative market uses for the crops, and developing varieties targeted to those systems.

In the case of cassava, landraces have been selected for centuries for specific uses (boil-and-eat, farinha, etc.). Landraces not only have excellent quality, but, generally, they maintain that quality over extended periods of time. Most landraces show intermediate to low root-yield potential, and that has been the reason for concentrating efforts in that area.

The process of adoption of "improved varieties" has not been as dynamic as expected. In most cases, farmers are not willing to trade quality for production. When we talk about quality, it is a complex trait which goes beyond flavor, taste and texture; it also includes flesh and external colors, storability, etc. The "improved varieties" have been relatively easily adopted by farmers producing for industrial purposes (starch, cassava flour, etc.). Another situation that has promoted the adoption of "improved varieties" is the case of certain ecosystems where there is a biotic problem attacking most of the existing landraces and causing losses of up to 100% of the crop. That has been the situation in Northern Brazil, where root rots destroy cassava plantations; in that case, farmers are willing to adopt varieties that may not comply with all their wishes, but offer the possibility of producing under those particular circumstances.

In conclusion, we can say that the diffusion of new varieties through the traditional schemes has been slow and difficult, mainly due to the assumption that farmers are mainly interested in increased production, and because we are not sure about the set of traits that the farmers have in their minds as a "desirable variety". This has opened the door for the development and application of methodologies that involve farmers in the process of varietal selection and diffusion.

## Characteristics of Root and Tuber Crops

Root and tuber crops present certain characteristics that make the application of participatory techniques desirable. First of all, their cropping cycles are usually long (i.e. cassava 9 to 18 months); therefore, any conventional breeding effort, where at least 6 crop cycles are necessary to evaluate genotypes for their adaptation and production potential, will take 8 to 10 years to develop genotypes that will then be put up for public consideration. Participatory evaluation allows for the intervention of farmers early in the breeding cycle, so that they can select the most desirable genotypes and these can immediately be multiplied.

The propagation rate of root and tuber crops is much lower than cereal crops. Making genotypes available for farmer evaluation and selection early on will result in faster diffusion of the preferred varieties.

As previously mentioned, propagation by cuttings can promote the proliferation of pests and diseases. Aside from that, the nutritional status of the planting material has a direct relationship to the production potential of the crop. Participatory breeding trials can serve as a vehicle for training farmers in the selection and improvement of planting material. They also serve as a vehicle for introducing "In-vitro clean" planting material.

In the case of those vegetatively propagated crops that retain the ability to produce sexual seed profusely (i.e. potatoes and cassava), farmers in certain regions are in the habit of isolating seedlings that sprout in their production fields, growing and evaluating them, and, if they see any potential, adopting them. In certain regions, due to the environmental conditions or a shorter crop cycle, there are fewer chances for the crop to flower and produce seedlings in the field. Supplying farmers with an array of genotypes from early generations in the breeding program can provide the genetic basis for farmer selection. It will also represent an important step for broadening the genetic base of the crop. In the case of cassava, certain landraces tend to dominate, according to the region (i.e. Venezolana in the North Coast). The traditional varietal releasing scheme usually considers the release of two varieties at the most, and usually one of them tends to dominate. Involving farmers earlier in the selection process will favor the selection of genotypes with specific adaptation to particular combinations of environment, soils cropping practices and market preferences, thus diversifying the crop genetic base.

## Participatory Evaluation of Cassava Varieties: Lessons from a Case

This case is discussed in more detail in a poster presented for this meeting. One of the important stages in the process is the diagnostic phase, where the main production and marketing problems are defined. Our experience, both here and in Brazil, tells us that farmers are expecting varieties to solve most of their problems. Varieties are a relatively cheap technological component that they can adopt and multiply without much additional expense. It is a component that, once it is adopted, will sustain its impact for a certain time without recurrent cost. Therefore, we start from the point that evaluating varieties is something that farmers want.

It was decided that a maximum of 10 varieties including 1 or 2 local landraces, will be provided to farmers. One important aspect is the source of planting material. The tendency is to provide planting material produced at the experimental station level for the "improved genotypes", and that the farmers will supply planting material for the local landraces. That usually sets a differential performance due to the better nutritional and phytosanytary status of the planting material multiplied at the station. Through the years, these genotypes will decline in their performance and tend to equal the one for the landraces. We should make every effort to provide planting material produced under similar conditions for all the evaluated genotypes, so that the bases that the farmer has for comparison are equal.

The on-farm evaluation has to be conducted under representative farmer conditions. It means that, on the one hand, we need to explain carefully the purpose of the trials and how they will be conducted as part of their commercial planting. On the other hand, FPR provides a very important tool for us to learn the cultural practices applied by farmers, and their rationale. This can have very important implications for a breeding program. Our experience with the participatory evaluation of cassava varieties in semiarid Brazil will serve to illustrate this.

Semiarid environments are characterized by 3-4 month rainy periods, with the rest of the year being dry. The normal practice for cassava production is to plant in the middle of the rainy season and leave the crop for 15 to 18 months until it passes through a second rainy period. Our breeding program had the objective of selecting genotypes that could be harvested in one-year cycles. When we explained this to farmers, they agreed that it would be very nice to have varieties that produce well in one year, but that they did not believe that was possible, and therefore suggested that part of the plots should be left for an 18-month harvest. We were able to demonstrate that our "improved varieties" could produce more than the local ones with a one-year cycle. But they were able to show us that, at 18 months, the crop could double its production, and, best of all, improve the quality for farinha production tremendously. Also, at 18 months, the difference between "improved" and landrace cultivars was much less. In consequence, we have incorporated the 18-month harvest into our conventional breeding program, in order to select genotypes that do well at both 12- and 18-month harvests.

With respect to the evaluation and the information which we collected and analyzed, it is very important not only to gather the subjective data provided by farmers when they react to a genotype, but also to gather as much quantitative descriptive information as possible to interpret farmers' expressions. Farmers do not use a uniform terminology to refer to the same aspects (i.e. paluda, aguada, vidriosa); therefore, there is a need to develop a glossary of these terms. As an example of the importance of collecting both types of data, we have seeen that, after the analysis, those cultivars referred to as good in terms of starch content had an average of 36.7% starch, while the ones referred to as bad only averaged 32%. That provides a very important selection criterion for us in the conventional breeding program.

**Perspectives**

Participatory evaluation of elite genotypes has provided good feed-back information on selection criteria applied by farmers in relation to the adoption of new varieties in root and tuber crops. There are certain considerations that need to be taken into account in order to analyze the perspective of this methodology in the broader spectrum of agricultural development.

a) The methodology has to be refined in order to get the maximum information out of the participating farmers, not only with respect to present cropping practices or markets, but in relation to their expectations and ideas.
b) The idea that the genotype alone can do miracles is seldom valid in the present day; therefore there is a need to integrate varieties and alternative cropping practices to be evaluated on farms.
c) Be sure the comparison among local and introduced genotypes is done on a similar basis, and not biased towards the latest.

d) Do not collect only subjective information, but conduct your usual breeding evaluations parallel to the evaluation by farmers. This may help you to interpret farmers' decisions from the quantitative point of view.
e) The production chain does not usually stop at the farm gate, there are also intermediaries (who are particularly interested in the quality and storability of roots), processors (interested in the starch content) and final consumers in the towns (interested in the quality), and these need to be integrated into a participatory breeding scheme.
f) Breeding cycles can be shortened by incorporating farmers' evaluations much earlier in the process. This will result in a mosaic of genotypes being adopted in a region. One aspect that needs to be taken into consideration is whether this procedure and its outcome is in accordance with National Program schemes for varietal release.
g) We should not limit ourselves to the information provided by farmers in terms of desirable traits, because we can handle genetic diversity that is not in their hands and therefore, they may not know about the potential of certain plant type (i.e. dwarf cassava) or certain root quality (i.e. waxy roots).

# DECENTRALIZATION VERSUS FARMER PARTICIPATION IN PLANT BREEDING: SOME METHODOLOGY ISSUES

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**Summary**

The role of decentralization and farmer participation can be studied both at the level of selection among finished products, i.e., varietal selection, and in the entire breeding process. Either *collaborative* participation, where farmers select among material they have grown in their fields, or *consultative* farmer participation can be used. This results in many types of decentralized and participatory breeding. These are defined so that all of the possible comparisons can be considered. The paper first looks at issues relating to varietal selection, then to plant breeding, and finally considers general issues of methodology.

Non-participatory varietal selection, using yield data from multilocational trials, can be compared with participatory varietal selection (PVS) in programs with equivalent levels of decentralization.

A comparison of non-participatory and participatory plant breeding (PPB) is more complex. Comparisons using equivalent levels of decentralization can be made, but completely non-participatory methods are impracticable. Any well-designed decentralized breeding program will have some consultative farmer participation.

Research into a major component of collaborative PPB, the selection of single plants by farmers in segregating generations, is possible and worthwhile. Although unbiased comparisons are difficult to make, the relative cost-effectiveness of selection by farmers and breeders can be investigated.

The role of farmers in consultative participatory breeding programs is limited but well defined. It is debatable as to whether it is worthwhile to research into these factors. For example, consultative participation is used to select local germplasm as parents, but the value of this process is hardly in doubt.

The experimental comparison of the adaptation of cultivars produced by PPB with those produced using conventional methods will allow a better understanding of the cost effectiveness of PPB methods.

Non-experimental case study investigations are a valuable research tool in natural science research and can be used to evaluate the benefits and cost-effectiveness of decentralization and farmer participation. Case study comparisons of decentralized participatory breeding with centralized non-participatory breeding are worthwhile, even though the effects of decentralization and farmer participation are confounded. For these studies, many more examples of participatory programs are required.

Participatory and non-participatory methods use different types of resources, complicating any study that compares the resources used by these two methods. The savings, or increased costs, of farmer participation in decentralized breeding need to be analyzed.

The localized impact of farmer participation on such things as biodiversity and empowerment could be studied using a socio-economic analysis of 'all' (in villages with participation) or 'nothing' (in villages without participation) effects.

The faster rate of adoption of new cultivars from PPB programs results from farmer participation rather than decentralization. The benefits of this faster uptake should be quantified in case studies.

## Introduction

In participatory varietal selection (PVS) farmers evaluate near-finished or finished products. Varietal selection was first used in the literature on farmer participatory approaches by Sperling *et al.* (1993). It describes a technique that lies within participatory plant breeding (PPB) as a whole[10]. However, in the same way that it is more informative to call someone who breeds plants a plant breeder rather than a biologist, so it aids clarity if PVS programs are referred as such, and not as PPB programs. The division of participatory crop improvement into PVS and PPB programs has been found helpful in this paper in analyzing the possible experimental approaches to separating the benefits of farmer participation from decentralization. Finally, it should be noted that successful PPB programs will finish with PVS—the selection amongst finished products.

This discussion paper draws particularly on experiences with a high altitude rice breeding program in Nepal (Sthapit *et al.* 1996), on a collaborative breeding program in maize between the KRIBHCO Rainfed Indo British Project West (KRIBP(W))[11] and Gujarat Agricultural University, and on a PVS program in KRIBP(W) (Joshi and Witcombe, 1996).

This paper examines the role of farmer participation and decentralization in breeding programs. It then looks at the comparisons that can be made in PVS and PPB to separate the

10 PPB and PVS can be described as two contrasting techniques within the area of Participatory Crop Improvement, but such terminology is not essential if PVS is recognized as part of a broader process of PPB.

11 An Overseas Development Administration, UK, and Government of India-financed project.

effects of decentralization and farmers' participation. Finally, some general issues concerning research methodology are discussed.

## The Purposes and Benefits of Farmer Participation

Farmer participation is invoked for many reasons. Of the types of farmer participation described by Biggs (1989) i.e., contractual, consultative, collaborative and collegial, most frequently collaborative approaches are used (Table 1). Goal setting is consultative participation and Ashby *et al.* (1996) are involved in collegial participation—scientists working to enhance the ability of groups of farmers to carry out research and development for themselves.

Witcombe *et al.* (1996b) assume that PPB will always involve the use of locally adapted germplasm, as this is the most obvious strategy to employ when the breeding goal is local adaptation. They also argue that, under such circumstances, only a small number of crosses have to be made. They discuss some of the advantages of PPB:

- at least one parent of any cross is well-adapted to the local environment,
- genotype x location interactions are greatly reduced, because selection is always in the target environment,
- the impact of genotype x year interactions is probably reduced since the local parental material is already adapted to the year to year variation that is likely to be encountered, and
- because few crosses are made, large $F_2$ and $F_3$ populations can be grown to increase the possibility of identifying transgressive segregants that give rise to desirable $F_4$ to $F_5$ progeny.

They point out that 'All these advantages apply to decentralized breeding regardless of whether increased farmer participation is employed. The role of farmer participation is to reduce demands on research station land[12], and eliminate the need for breeders to do single-plant selection in many of the generations. Most importantly, it ensures that all farmer-relevant traits, including post-harvest ones, are evaluated. PPB is particularly efficient when post-harvest quality traits are involved that are difficult to assess in the laboratory. Farmers are able to select for such traits because farmers and their families are the ultimate judges of quality in any cultivar.

12 However, decentralization can be carried out at many levels, and at the higher ones it may not involve the use of on-farm trials.

**Table 1. Farmer involvement in participatory varietal selection and in participatory plant breeding—the purpose and benefits**

| Farmer involvement in: | Purpose/benefits | References |
|---|---|---|
| **PVS** | | |
| Selection by farmers amongst finished products in trials on their own fields | Identify superior material for immediate benefit of participants and for wider dissemination. Increase the rapidity at which new cultivars are taken up. Provide information on traits that farmers consider important. | Joshi and Witcombe 1996; Maurya *et al.* 1988, Sperling *et al.* 1993. |
| **PPB** | | |
| Defining goals<br>Planning and deciding what to cross. | Improve efficiency. Reduce risk of failure. | Ceccarelli *et al.*, 1996; Sperling *et al.*, 1993; Weltzien *et al.*, 1996; Witcombe *et al.*, 1996b. |
| Provision of landrace material for the selection of crosses | Increase likelihood of specific adaptation. | Witcombe *et al.*, 1996b |
| Maximizing specific adaptation | Breed appropriate varieties for farmers in marginal environments. | Ceccarelli *et al.*, 1996 |
| Line selection from bulk populations provided by breeders<br>Selection from early generations | Breed appropriate varieties for farmers in marginal environments. Further reduction in risk of failure over non-participatory decentralized breeding. Reduce requirement for resources. Efficient selection for postharvest traits. Empower farmers.<br>Enable more rapid uptake of new cultivars. | Ceccarelli *et al.*, 1996; Kornegay *et al.*, 1996; Sthapit *et al.*, 1996; Thakur 1995; Witcombe *et al.*, 1996b; de O. Zimmerman, 1996. |
| Generating variability for breeding programs | Increased efficiency. Breeding for specific environments. | Weltzien *et al.*, 1996 |
| Generating biodiversity on farmers fields | Maintenance of diversity to decrease genetic vulnerability of crops. | e.g., Witcombe *et al.*, 1996a, b |
| Satisfying different end uses | Breeding for specific socio-economic niches | Voss, 1996 |
| Control and empowerment | Enhancing farmers' skills, access, control and decision making | Sperling, 1996. Ashby *et al.* 1996. |

## Participatory Plant Breeding and Decentralized Breeding. What Are the Differences?

### *Decentralization of Varietal Testing without Farmer Participation*

Decentralization is any departure from a centralized breeding program towards a more decentralized one. However, what is decentralized and the scale on which decentralization can take place differ greatly. Decentralization can involve local decision making and local budgets, or decentralization may only be at the activity level, with all of the decision making retained centrally. The scale of decentralization can refer to very different processes, e.g., decentralization from international to national, from national to regional, and from regional to sub-regional levels. The decentralization can also involve very different levels of farmer participation, so decentralization and participation are usually confounded. For example, the following components typical of participatory programs could be involved in decentralized breeding:

- the use of local parental materials;
- the use of farmers' fields;
- farmer management of test sites;
- the use of farmers' observations and opinions;
- the use of complex selection criteria.

This confounding of decentralization and farmer participation is a recurring theme in this paper, and the major obstacle to separating out the effects of decentralization and participation.

In the literature, these aspects are ignored, because decentralization is simply justified on the grounds of controlling genotype x environment interactions. The purpose of decentralization is to exploit 'cross-over' interactions (Ceccarelli, 1994; Ceccarelli *et al.*, 1994; Simmonds, 1984, 1991; Virk and Mangat, 1991) to produce cultivars adapted to more specific environments. Cross-over interactions can theoretically occur between any level e.g., between countries, between regions and between sub-regions. However some decentralized programs may fail to exploit cross-over interactions because they are still insufficiently decentralized.

Ceccarelli *et al.* (1996) gives an example of the first level of decentralization in a CGIAR center international breeding program. Instead of sending the same material to each country in the expectation of wide adaptation, different genetic material, all involving locally adapted material, is sent to different north African countries. The choice of parental material is decentralized on a country basis, and the crosses are sent to the countries for which they are targeted so that selection is in the appropriate environment.

In a conventional multilocational testing system of finished products, any attempt to select for specific rather than wide adaptation is decentralization. This can be achieved in national programs by dividing multilocational trials into zones or into trials for specific plant types. For example, the All India Co-ordinated Crop Improvement Projects (AICCIPs) are decentralized to the extent that most of the programs have multilocational trials that are divided into zones (Table 2). Clearly, some programs are more decentralized than others depending on the number of zones that are employed. Another means of decentralizing is to breed for specific adaptation by having trait-specific trials. Hence, in the AICCIPs there are trials for specific maturities, e.g., in rice, sorghum and pearl millet; for crop types, e.g., in groundnut and wheat; for agro-ecosystems, e.g., in rice; and for late and early sowing in wheat (Virk *et al.*, 1995). They argued for the need for more decentralization to increase the probability of obtaining more specifically adapted genotypes for low-resource farmers. This should be done by creating more trials for:

- early, mid-late and late-maturing genotypes;
- target regions and specific agro-ecological situations;
- genotypes having specific traits identified by farmers as desirable, such as high fodder yield.

**Table 2. Number of zones and average number of locations within zones for selected crops in the AICCIP multilocational trials system**

| | Rice | Wheat | Pearl millet | Sorghum | Groundnut | Chickpea |
|---|---|---|---|---|---|---|
| Zones | 3 | 7 | 2 | 1 | 5 | 5 |
| Locations within a zone | 7 | 7 | 15 | 12 | 4 | 4 |

This process of decentralization encourages greater genetic diversity in the use of parental material, as breeders select different types of germplasm for different trials. Without decentralization, material with wide adaptation has to be selected. This results in a restricted range of genotypes that flower at the same time across a wide range of photoperiods and thermal environments.

Witcombe and Virk (1996) describe decentralization in a number of case-study countries. They found that 'Research stations usually are situated in the range of agro-ecological situations in any country, but often there is only a single location per agro-ecological zone. Hence, the number of trial sites per trial may be as low as one in some trials in Nepal, and initial trials are carried out in only 2 locations in Kenya, Zimbabwe and Bolivia. In India, the number of locations per zone can be as low as four in groundnut and chickpea trials. Although there are more test sites in the later stages of testing, it is clear that the number of test sites in any trial in any country is not adequate to represent the diversity of any particular region.' In all these decentralized systems the role of farmers is restricted to the testing of a small number of scientist-identified cultivars in minikits and adaptive trials, usually at a very late stage in the program, or after release.

*Decentralization of Varietal Selection with Farmer Participation*

Decentralization *per se* allows a change in selection strategy, without any change in the degree of farmer participation. However, 'the most extreme decentralization is farmers' participation in selection under their own conditions' (Ceccarelli *et al.*, 1996). Decentralization is, therefore, often discussed only in the context of a having a participatory component (e.g., Eyzaquire and Iwanaga, 1996).

Moving varietal testing from research station trials to farmers' fields is almost always (but not necessarily) a process of decentralization. It can be decentralization from a program previously targeted at wide adaptation, or further decentralization of an already decentralized program. There are various forms of participatory varietal selection, all of which involve collaborative participation as the varieties are grown by farmers on their fields, although the reliance placed on farmer evaluation can vary (Table 3).

**Table 3. Some methods of varietal selection with varying degrees of farmer participation (summarized from Witcombe *et al.*, 1996b)**

| Methods in increasing order of farmer participation | Evaluation includes | Example institutions |
|---|---|---|
| 1. Researcher-managed on-farm trials. Replicated design. (Farmers may be involved in evaluation) | Yield data (Farmer evaluation) | Research |
| 2. Farmer-managed, replicated design, on-farm trials, with scientists' supervision. Several entries per farmer | Yield data Farmers' perceptions | Research |
| 3. Farmer-managed, unreplicated design, on-farm trials. One cultivar per farmer. Replication across farmers | Yield data and farmers' perceptions, or farmers' perceptions only | Research Extension NGO |
| 4. Farmer-managed trials. No formal design either within a farm or across farmers | Informal, anecdotal, entirely on the basis of farmers' perceptions. | NGO Extension Research |

[1]NGO = Non-Governmental Organisation

*Decentralization of Plant Breeding with Farmer Participation*

Only two types of PPB programmes, *consultative* and *collaborative,* are considered here out of the four types of farmer participation (contractual, consultative, collaborative and collegial) defined by Biggs (1989). In this paper, consultative and collaborative research is separated by whether farmers are involved in growing genetic material themselves. In consultative breeding programmes, farmers are consulted at every stage in order to set goals and choose parents that are entirely appropriate. However, the crucial point is not just the frequency at which farmers are consulted but how much voice they have in the final decision. In collaborative programmes, farmers grow the early, variable generations and select the best plants amongst them on their own fields. In consultative breeding, collaborative research is employed once finished products are given to farmers (often those that were involved in the consultation process). However, in collaborative programmes, there is no discontinuity between the end of breeding new products and the start of selection amongst finished products.

The choice of consultative or collaborative methods will depend on the crop (e.g., inbreeding or outbreeding) and the availability of resources (e.g., access to farmers keen to collaborate). However, there is a gray area between consultative and collaborative programs, when farmers are brought to research stations and asked to make single plant selections in the breeders' trials (e.g., de O. Zimmerman *et al.*, 1996).

The degree of farmer participation in collaborative PPB can differ greatly, although it is always an important component (Table 4).

**Table 4. Examples of collaborative plant breeding in predominantly self-pollinating crops with varying degrees of farmer participation (summarized from Witcombe *et al.*, 1996b)**

| Methods in increasing order of farmer participation | Site specificity | Example |
|---|---|---|
| 1. Starting from the $F_3$ to $F_4$ farmers and plant breeders collaborate to select and identify the best material on farm (and also on station). Farmers select. Plant breeders facilitate the process. Release proposal prepared by plant breeder | Possible to run selection procedures on early generations in more than one location | Sthapit *et al.* (1996) |
| 2. Breeder gives $F_3$ or $F_4$ material to farmers. All selection left to farmers. At $F_7$ to $F_8$ or later, breeders monitor diversity in farmers' fields and identify best material to enter in conventional trials | Extremely easy-to-run selection schemes in many locations | Salazar (1992) |
| 3. Trained expert farmers make crosses and do all selection with or without assistance from breeders. Breeders can place best material in conventional trials | Specific to farmers' requirements | None yet-- second generation technology |

[1] CGIAR = Consultative Group on International Agricultural Research, NARS = National Agriculture Research Systems, DC = Developed Country

### *What Comparisons Are Possible?*

The contributions of centralized and decentralized, participatory and non-participatory collaborative and consultative participation, and PVS and PPB allow for the classification of breeding programs into many categories (Table 5). However, many types of programs are not possible or are unlikely, such as centralized PPB (it has to be decentralized) and collaborative centralized breeding.

**Table 5. Centralized and decentralized plant breeding varying with type and extent of farmer participation and type of program (PVS or PPB).**

| Decentralized | Centralized |
|---|---|
| *Varietal selection* | |
| **Decentralized without farmer participation.** Varieties are selected from scientist-managed trials conducted in the target environments to breed for specific adaptation. | **Centralized without farmer participation.** Classical centralized breeding for wide adaptation selecting for high across-location mean yield in multilocational trials. |
| **Decentralized consultative.** Varieties are selected from scientist-managed trials jointly by farmers, who are invited on station, and scientists. | **Centralized consultative.** Farmers can be brought onto research stations to evaluate trials, but farmers cannot evaluate wide adaptation. However, farmers can be used to identify the best multiple selection criteria. If they select varieties for their own fields, the program is decentralized to the farmers' locations. |
| **Decentralized collaborative.** All PVS is decentralized to farmers' fields. All is collaborative because farmers grow the varieties themselves on their own fields. | **Centralized collaborative?** Can collaborative participation be used without decentralization? |
| *Plant breeding* | |
| **Decentralized without farmer participation** Decentralized non-participatory breeding occurs when breeding stations are located in specific environments with responsibility to breed only for that environment. However, most well-targeted decentralized programs will become consultative. | **Centralized without farmer participation.** Target traits are those that give wide adaptation (e.g., dwarf height, photothermal insensitivity, and bland grain quality appealing to the largest group of consumers). |
| **Decentralized consultative**. Breeders consult farmers to chose parents that can be both landraces and modern varieties, that are liked by farmers. Farmers are also consulted to target appropriate traits for selection and farmers visit the breeders' research plots and comment on the new material. | **Centralized consultative.** Consultative methods can, with some difficulty, be applied to centralized programs. Farmers are consulted on target traits. Parents are chosen to breed for wide adaptation, so farmer participation helps little. Farmers are brought onto research stations to evaluate early-generation trials, but they can only evaluate phenotypic traits and not wide adaptation. The more consultation, the more the tendency will be to decentralize. |
| **Decentralized collaborative** Farmers collaborative by selecting plants among variable, early generation material. Collaborative breeding also exploits all of the benefits of consultative breeding. | **Centralized collaborative?** Can collaborative participation be used without decentralization? |

Considering all of the above methods, any comparisons are possible including:

- Centralized versus decentralized programs, neither of which have farmer participation. This is a topic which is not pursued in this paper, but it would allow the benefits of decentralization *per se* to be evaluated.
- Participatory decentralized methods versus non-participatory centralized methods. In this comparison, the roles of decentralization and farmers are confounded.
- Participatory decentralized methods versus non-participatory decentralized methods. This is the only comparison that allows for an unconfounded assessment of the role of farmers.

Comparisons that can be made to examine the roles of decentralization and farmer participation will be considered first for varietal selection, and then for plant breeding. However, the considerations that follow conclude that the objective should not be a comparison of two strategies with the same levels of an inexactly defined decentralization with different degrees of an inexact concept like participation. Rather, specific innovations should be tested, just as with any methodological development, and the cost and benefits of participatory programs evaluated.

## Varietal Selection

### *Comparing Non-participatory and Participatory Decentralized Varietal Selection*

To separate experimentally the benefits of decentralization from those of farmer participation, two programs having the same objectives of highly contrasting levels of farmer participation could be compared. This is most feasible when testing finished products by comparing non-participatory varietal selection (selection using data from multilocational yield trials) with participatory varietal selection (selection using participatory trials on farmers' fields with farmer management). The target area of the non-participatory multilocational trials of a decentralized program would be identified, and, within that same region, the same genetic material in the multilocational trials would be tested in farmer participatory trials.

As a control, the non-participatory method must not be consultative but use the most common selection strategy employed by breeders i.e., the least farmer-oriented selection criterion, an almost total reliance on selection for yield. However, it would be interesting to see if breeders modify the selection procedures in their multilocational trials, once the results from farmers are seen. The easiest change to make is from non-participatory centralized breeding to a consultative participatory one. It is very simple to modify selection criteria for promotion of entries from one trial stage to the next. Selection could be for multiple traits of importance to farmers, such as a combination of grain yield, stover yield and maturity. The more farmers' criteria are used in the selection, the more the program becomes consultative participatory research.

To the author, at least, the outcome of such an experiment and the benefit from farmer participation can be predicted easily from prior experience:

- Farmer participation would result in the selection of more appropriate varieties. Farmers would prefer different varieties to those that perform 'best' i.e., yield the most, in the multilocational trials
- Farmers would adopt and grow a greater range of genetic material. They would be exposed to a greater choice than the restricted set of varieties that would be released from non-participatory multilocational trials.
- The uptake of new genetic material by farmers would be greatly accelerated.

The experimental difficulties, as well as the benefits of farmer participation, can also be anticipated:

- How would resources be equalized between the participatory and non-participatory methods (see below for a more detailed discussion on this topic)
- How could institutional issues be resolved to obtain a fair comparison? For example, the breeders conducting the multilocational trials would have to be unaffected by an influx of participatory workers, but be prepared to collaborate by providing genetic material. Alternatively, the participatory workers would have to conduct the multilocational trials as a control, but multilocational trials can be conducted well or badly.

However, is an experimental approach required? It should be sufficient to demonstrate the benefits of farmer participation, whilst costing the resources required to involve farmers.

## Plant Breeding

### *Comparing Participatory with Non-participatory Decentralized Methods*

**Can comparisons be made with equivalent decentralization?** In participatory breeding, the decentralization may be more extreme than in non-participatory decentralized methods because it restricts the breeding process to only a few villages or farmers. It may result in the benefits of PPB being more geographically restricted. If true, it would represent a major disadvantage of a participatory approach. For example, Sthapit *et al.* (1996) carried out PPB in two villages in Nepal with 18 farmers and Kornegay *et al.* (1996) used three farmers from one district of Colombia. De O. Zimmerman (1996) used farmer visits early in the breeding program to three researcher-managed locations in Brazil. At the $F_7$ generation, 10 farmers were involved in testing the lines. Resource requirements clearly restrict the number of farmers and villages, and hence the number of environments. However, this does not necessarily lead to highly specifically adapted products as compared to using non-participatory methods. In non-participatory, as well as participatory programs, selection in segregating generations tends to be restricted to very few locations. Also, in both types of program, finished products can be tested more widely than the products of earlier generations. For example, Sthapit *et al.* (1996) entered Machhapuchhre-3, a product of PPB, into national rice research program trials in Nepal. As a result of its successful performance, it has been released officially.

Farmer participation *per se* does not mean that decentralization has to be more extreme. It is thus theoretically possible to separate the role of farmer participation from the role of decentralization by comparing programs with equal decentralization. However, even if this can be achieved, can the two treatments, farmer participation and no farmer participation, be established?

**Can a comparison be made with clear differences in farmer participation?** A comparison is required of farmer involvement or non-involvement in plant breeding. However, it is difficult to create, for comparative purposes, a meaningful non-participatory decentralized plant breeding program:

- Should decentralized breeding deliberately not use locally adapted parents? Even though centralized breeding rarely employs locally adapted material, many would argue that decentralized breeding should involve local material (e.g., Ceccarelli *et al.*, 1996). However, this cannot be done without involving farmers—at the very least they need to be consulted about what they are growing, and material has to be collected, indirectly via a gene bank or directly from them.
- Should the decentralized breeding program ignore farmers' preferences for qualitative traits? It would be unrealistic to allow this error in a comparison of methods. It would be known from the outset that the decentralized program was doomed to fail, if the material in the program did not match farmers' preferences.

Therefore, unless these two important elements of consultative participation are incorporated in the decentralized program, thus reducing the impact of the comparison, there is a likelihood that the whole experimental comparison would not be justified. It would be known very early in the comparison that the non-participatory method was doomed to failure.

From such considerations, it appears that a simple, straightforward comparison of decentralized breeding, with and without farmer participation, is not possible. Essentially, *this is because any truly decentralized breeding program must have some consultative participation.* Comparisons can only be made of decentralized breeding programs having different amounts and types of farmer participation.

*Specific Issues in Collaborative and Consultative Participatory Breeding*

**Collaborative participatory breeding—comparing farmers' and breeders' selections.** One experimental approach is to test the role of farmers in collaborative breeding programs. The effectiveness of selection by farmers and breeders can be compared. In Colombia, a comparison has been made between farmers' and breeders' selections in beans (Kornegay *et al.* 1996). Breeders tended to select for yield and stress tolerance while farmers placed greater emphasis on quality traits. Farmers' selections and breeders' selections for beans in Rwanda were compared, and farmers' selections were found to be more successful (Sperling *et al.* 1993). However, this study was facilitated by what may be an unusual set of circumstances—a group of researchers working both with farmers and with plant breeders. It may be more usual and more cost effective to expect breeders to make comparisons between methods. However, once breeders are involved with farmer selection, it is difficult to make a strict comparison; farmers learn from breeders and breeders learn from farmers, so their selections will become increasingly close as their selection criteria converge. Indeed, Sthapit *et al.* (1996) found excellent agreement between farmers' and breeders' selections 'because farmers were carefully chosen for their skills, and breeders had been exposed to farmers' preferences.'

It is safer to assume that, once participatory methods are adopted, breeders and farmers will learn from each other so that their selections will increasingly converge. The research issue would then involve a comparison as to the costs involved in achieving these results. To compare costs, the genetic material, total population size, and the numbers of populations in the two schemes ought to be equal. The question has to be resolved as to what population sizes and numbers are used in the comparison, as the comparative advantages of farmers and breeders could differ greatly, depending on the parameters chosen. It may be that breeders have the greatest advantage when there is a large number of smaller populations and efficient trial designs are used, and farmers when there is a small number of large populations in which single plant selections are be made. Inevitably, comparisons have to be made with arbitrarily selected numbers. In the study by Kornegay *et al.* (1996) 18 $F_2$ populations were evaluated and it was decided that both farmers and breeders would continue with the best five.

**Consultative participatory breeding—should the importance of consultation be verified?** The extent of farmers' involvement in planning and in the provision of parental material can be varied, but whether comparative studies are worthwhile is debatable. For example, farmer consultation will usually lead to the identification of locally adapted, farmer-acceptable genotypes and their use as parents. There is limited experimental evidence that the use of local material is a superior strategy because rarely is the required control treatment used in participatory methods i.e., crosses where none of the parents have specific adaptation to the target environment. However, Kornegay *et al.* (1996) show that the best line was from a cross between a local landrace and a CIAT modern variety: 'Only two lines were selected from crosses between modern varieties; the rest came from crosses of modern varieties with local materials. This shows that the inclusion of local varieties in breeding programs is necessary to recover quality traits appreciated by farmers.' Of course, such conclusions are highly case specific, because it will depend on the genetic variability available in local and exotic materials. Various authors argue strongly for the inclusion of local material as parents (e.g., Ceccarelli *et al.*, 1996 and Witcombe *et al.* 1996b). It appears that research into this topic is, therefore, not of the highest priority, and is only likely to confirm that the use of locally adapted material is a valuable part of a decentralized breeding strategy.

In the same way, the value of using selection traits identified in consultation with farmers is also not in question. If it were to be tested experimentally, it would be easier to do so in a PVS program than a PPB program.

*How Widely Adapted Are The Products of PPB?*

A commonly encountered criticism of the involvement of farmers in breeding research is that the products of any participatory program will be narrowly adapted, thus reducing the cost effectiveness of any research. This issue can be examined by testing the adaptation of the products of PPB, and by comparing them to the products of conventional breeding.

**The size of cultivar domains**. The benefits of a PPB program will depend on how widely adapted its products—the larger the area to which a cultivar is adapted (its domain) the more cost effective PPB will be. Witcombe *et al.* 1996b argue that 'Even though PPB is not targeted at broad adaptation there is no reason to suppose that the products of PPB will have very narrow domains. In conventional breeding, many breeding programs are based at only one location, and multilocational trials are used to test and select the finished products. In PPB, early-generation, multilocational testing can be employed using farmer participation to ensure that cultivar domains are not too narrow.' Sthapit *et al.*, (1996) used this approach in their PPB program by replicating the same early-generation material in two villages.

As part of the PPB programs in rice in Nepal and maize in India, we are attempting to find out how large the cultivar domains of the products are. Machhapuchhre-3 rice from Nepal performed well in multilocational trials and is presently being tested outside of the villages where it was bred (Sthapit *et al.* this conference). The breeding products, white-grained, early composites, GDRM 185 and GDRM 186, from the maize-breeding program will not only be tested in multilocational trials, but also with many farmers in the three districts of the project in western India, in eastern India and in Nepal. Plans are also underway to distribute material to Zimbabwe.

**Comparing the outputs from PPB with those from centralized breeding**. Varieties of a participatory plant breeding program for rice grown at high altitudes in Nepal were compared with those from a conventional centralized system (Sthapit *et al.*, 1996). The variety from the PPB program was far better adapted to high altitudes then any of the varieties from conventional, centralized breeding. In a decentralized breeding program for maize in India (Witcombe *et al.* 1996b) new maize varieties are yielding more than those that have come from an already partially decentralized breeding program.

*Case Studies*

The use of case studies to draw more general conclusions has been used effectively in natural science research (e.g., Cromwell and Wiggins, 1993; Ostrom, 1990). Obviously to use this approach, case studies are needed, but there are not many published reports on participatory varietal selection and even fewer on participatory plant breeding.

In the author's opinion, the usefulness of participatory plant breeding can only be established by having many more examples. In these examples, comparisons of the products of participatory breeding need to be compared with those from less participatory, centralized breeding. Materials produced from different types of program should be tested with farmers over several years. When there are many examples of PPB programs from many crops, in many countries, the value of participatory methods can be established or disproved. However, all such case studies will confound the role of farmer participation and decentralization unless deliberate, and inevitably expensive, attempts have been made to enable comparisons.

## General Issues in Methodology

### *Can Resource Allocation Be Compared Easily between Participatory and Non-participatory Methods?*

If the efficiency of involving farmers in breeding is to be determined, then methods involving different levels of farmer participation should be compared. To draw valid conclusions on which is the best method, each method (experimental treatment) should have the same resources allocated to it, but how can this be achieved? Decentralized breeding without farmer participation uses research station land or land rented from farmers, is heavily dependent on technical breeding skills, and uses limited amounts of travel. Participatory methods use less research station land and do not involve paying rent to farmers, involve social as well as natural scientists, and more off-station travel. Costs of these components will vary greatly according to circumstances.

It would also be impossible to say whether the quality of scientific endeavor in the two approaches is equal because different skills are needed in the two methods.

Participatory methods are much more cost effective when pre-existing linkages between farmers and existing organizations (GOs and NGOs) are used. However, there will be a marginal cost for the use of such pre-existing linkages. The time will be required of salaried personnel of the GO or NGO that agrees to collaborate in a participatory breeding program. On the other hand, there will also be difficult-to-quantify benefits to the organization, such as increased awareness of issues relating to the seed of improved cultivars.

### *Calculating the Costs of Farmer Participation*

**Costs.** As far as the author is aware, no economic analysis of a participatory plant breeding program has so far been published[13]. Even for conventional programs costs are not readily available, and costs of participatory methods have not been published. Ashby *et al.* (1996) discuss the costs of labor for trials managed on-farm by extension services and by farmers' research committees (CIALs). They found that the farmer participatory approach led to great savings in salaried labor, particularly when the members of the CIAL were fully trained.

In Nepal, a decentralized breeding program with active farmer participation was underway using land rented from farmers. A decision was made to involve farmers in the selection of segregating material from the viewpoint of saving costs in land rent and in the costs of salaried labor in carrying out single plant selections (Sthapit *et al.* 1996). However, no formal analysis of cost savings have been made of this increased farmer participation. In Kenya and Bolivia, participatory methods are used to reduce the costs of on-station testing (Witcombe and Virk, 1996). The varietal trials are run on farmers' fields by the researchers to increase in a cost-effective way the number of testing sites.

These examples of cost savings using participatory methods may appear surprising, as a common criticism of participatory methods is the increased costs that they entail. However, these appear to be genuine examples of cost savings, and more research is required on the costs of involving farmers in research.

In contrast, in a PPB program for an open-pollinated crop, maize, the high cost of farmer participation caused a reduction in participation from that originally planned. This program is being carried out in India as a collaboration between KRIBP(W) and Gujarat Agricultural University. Farmers' practices needed to be changed for time of sowing and the selection of fields for maize cultivation. This was because the experimental maize plots need to flower at different times and be separated physically from other plots. This created demands on salaried staff time in arranging this practice, and burdens on the farmers involved as they had to make radical changes to the way they farmed their land. Also, during single-plant selection in the maize populations, many plants had to be removed before flowering. The rejected plants do not produce any grain (unlike the case of self-pollinated crops where plants can be rejected after harvest).

The collaborative approach was abandoned because of the transaction costs of persuading farmers to remove plants before flowering, and the transaction costs of arranging suitable compensation. Nonetheless, there has been consultative participation. Farmers have been consulted to set objectives, to identify parental material, and to identify important traits for selection. To an extent, the program is also collaborative, as farmers are evaluating the

13 There is also the complication that participatory programs are incurring additional research costs to be able to document these new methods.

acceptability of unfinished products from the breeding program. Farmer selection may be reintroduced into the program once the maize populations in the breeding program are more uniform, so they require less roguing, and seed is available in much larger quantities so that larger plots can be grown to avoid the need for isolation.

**Success versus failure**. A successful participatory program is more cost effective than a program that fails farmers, to produce any product that is adopted by farmers because it ignores them. If farmer participation results in desirable material being produced and adopted by farmers, then any increased costs caused by farmer participation can be justified. Again, this underlines the need for more case studies, to see how often PPB succeeds where existing systems have failed.

*Examining the Impact of Farmer Participation on Biodiversity and Empowerment*

Among the many reasons why farmers are involved in participatory research is to increase biodiversity and empowerment (Table 1). Both biodiversity and empowerment should increase more in the villages in which participatory plant breeding is undertaken than in villages which are not directly involved. The impact of farmers' participation can, therefore, be evaluated in a participating village, and compared with a control that is in nearby non-participating villages with a similar socio-economic and agro-ecological environment. Costs, as well as impact, need to be measured. The impact of empowerment will be much more difficult to measure than biodiversity.

*Quantifying the Benefits of a More Rapid Application of Research Results*

The speed at which research results are adopted has an important influence on the cost benefit ratio of the research. If farmers grow newer, superior cultivars than would be the case under non-participatory methods they gain an economic benefit that is related to the extent of their superiority. Sthapit *et al.* (1996) point out the greater speed at which the results of PPB can be applied compared to non-participatory methods. 'In a conventional breeding system, material such as Machhapuchhre-3G and Machhapuchhre-3C would have still been in very preliminary stage of varietal screening in very small plots and still at least 7 years away from being given to farmers for them to grow in minikit tests. A release proposal can be submitted three years earlier than in the conventional system, even if time is allowed to select for greater uniformity within a farmers' cultivar to satisfy seed certification requirements.'

Farmer participation, rather than decentralization, leads to faster uptake and release of cultivars. This benefit of farmer participation, as opposed to decentralization, can be quantified. Again, there is a need for more case studies that can be analyzed in this way.

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# METHODOLOGICAL ISSUES FOR SEED SYSTEMS OF CROP VARIETIES DEVELOPED THROUGH PARTICIPATORY PLANT BREEDING

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## Introduction

The mandate of an institutional crop breeding program is usually to raise national food production. It is, therefore, logical that it concentrates its efforts on the high production environments where higher yields are possible through improved varieties as compared to marginal environments. Yet the major challenge in plant breeding today is how to address the problems of resource-poor farmers in marginal environments, who have often contributed important genetic diversity to the institutional system with little benefit in return.

Few researchers questioned whether the present system of generating varieties and testing (research process) addresses farmers needs. There is growing evidence that plant breeding strategy and seed regulatory frameworks in developing countries are neither sufficiently responsive to the needs of resourcepoor farmers nor adequately adapted to the changing institutional environment of national research and seed sectors (Tripp & Heide, 1996; Witcombe and Virk, 1996). Evidence suggest that current seed regulatory frameworks are inadequate and often detrimental to farmers' welfare, particularly that of marginal farmers.

There is now substantial evidence that farmers maintain and improve their landraces in a continuous process of selection. Greater participation of farmers in selection process has resulted positive impacts in variety selection and crop improvement in Colombia (Kornegay *et al.*, 1996), India (Joshi and Witcombe, 1996), Nepal (Sthapit *et al.*, 1996; Joshi *et al.*, 1995), Peru (Valdivia *et al.*, 1996), and Rwanda (Sperling *et al.*, 1993).

Where plant breeding is not well developed but scope exists to obtain varieties externally, farmers can be involved in participatory variety selection (PVS) trials. Witcombe *et al.*, (1996) suggested that PVS is a more rapid and cost-effective way of identifying farmers-preferred cultivars if a suitable choice of cultivars exists. Alternatively, Participatory Plant Breeding (PPB), in which farmers select varieties from segregating material under their own target environment (Witcombe *et al.*, 1996, Sthapit *et al.*, 1996), is one of the ways forward to meet the needs of economically deprived groups of farmers.

The methodologies reported are variable and no efforts are being made to institutionalize and legitimize PPB approaches. Various approaches reflect the individual judgments and experiences of the plant breeders concerned and their institutional flexibility to new initiatives. Some of these case studies were documented in some recent proceedings (Sperling and Loevinsohn, 1996; Eyzaguirre and Iwanaga, 1996).

There are many PPB methods that have different degrees of farmer participation. Most works are concentrated

- in self-pollinated species such as rice, barley, beans;
- on marginal and stress environments;
- on local landrace as one of the parents;
- on a selection under target environments (specific adaptation);
- on decentralization of testing procedures.

There are cases where PPB work has been done in open-pollinated crops such as maize (Joshi and Witcombe, 1996) and pearl millet (Weltzien, 1996). Valdivia *et al.*, (1996) used a PPB approach in vegetatively propagated crops such as potato. In the majority of cases, large varietal options were provided by breeders by exposing farmers to advanced lines or segregating populations or composites. In self-pollinated crops, segregating populations ranging from F2 lines to F5 bulk populations are given to farmers for testing. In rice, Thakur (1995) screened F2 materials in farmers' fields, but subsequent generations were selected by researchers. In the Philippines, farmers themselves are involved in crossing and selection from the progeny of crosses between traditional and improved cultivars of rice (Salazar, 1992). In India, Weltzien (1996) has set up on-farm sites for screening prereleased lines of pearl millet. Joshi and Witcombe (1996) have started PPB in open-pollinated maize crop with the fourth random mating generation of a composite created from six farmer-accepted, open-pollinated cultivars. In Syria, Ceccarelli *et al.* (1996) also screened large numbers of segregating lines of barley under target environment using landrace as one of the parents. These case studies provide an interesting range of different approaches to PPB.

In Nepal, farmers set the breeding objective and screened F5 materials in their fields and promoted after series of field and postharvest evaluation (Sthapit *et al.*, 1996). Sthapit *et al.*, (1996) demonstrated that varietal diversification has been achieved within three years in Chhomrong and Ghandruk villages (1800-2200 m asl) in Nepal and, this approach also offered the immediate benefit of such resources to the farming communities. These case studies have demonstrated that PPB helps to create genetic diversity in farmers' fields and to conserve biodiversity, as the process leads to the development of different varieties by different farmers. These methods have been shown to be very successful in a stress environment but there is a good possibility that they can be applied in high potential areas as well.

**Institutional Uptake**

In recent years, the uptake of participatory variety selection (PVS) and PPB in Nepal is very positive. Formal sectors are also showing willingness to try the methodology as a pilot project. The temperate rice-breeding program of the Agricultural Botany Division, Nepal Agricultural Research Council (NARC) is in the process of institutionalizing PVS and PPB. Besides LARC, Area Projects such as CARE/Nepal, and ACAP have taken up this approach with professional collaboration of a local Non-Government Organization in Nepal, Local Initiatives for Biodiversity, Research and Development (LI-BIRD), as their major research and development strategy to reach rural masses. A local NGO LI-BIRD has already initiated such a methodological test in the Terai area of Nepal in collaboration with ODA Plant Science Research Program. PVS and PPB is likely to be more successful in high yield potential areas because the areas have a more assured supply of resources, and farmers are more responsive, knowledgeable and have higher risk-bearing capacity than their counterparts from the marginal mountain areas.

## Some of the Key Elements of PPB

- involves farmers at the initial stage for setting breeding objectives;
- identification of farmers needs;
- uses local landraces as a parent;
- uses very few carefully selected crosses;
- offers large options to diverse farming groups;
- farmers manage and evaluate the materials in target environment;
- farmers decide about adoption or rejection;
- farmers have control over the material;
- testing methodology is simple.

## Methodological Issues Raised from the Case Study of Nepal

Recently, the Variety Release and Registration Committee (VRRC) of Nepal released Machhapuchre-3 (Fuji 102/Chhomrong Dhan) the first variety bred through PPB in Nepal (Joshi *et al.*, 1996). This work was done at Lumle Agricultural Research Center, an ODA-funded multidisciplinary agricultural research station. Owing to mandate change, LARC no longer works in high-altitude rice. The PPB process was well-documented (Sthapit *et al.*, 1996), and the monitoring of varietal spread by LI-BIRD with the participation of Community Based Organization (CBO) is in progress. In a conventional breeding system, material such as M-3 which is at F7 stage when released, would have still been in very preliminary stage of varietal screening in a very small plots and still at least seven years away from being given to farmers for them to grow in farmers' field and minikit tests. The economic and social gains which farmers will forego due to the cultivation of inferior quality crop varieties are significantly large. This example has clearly demonstrated the comparative advantage of PPB over conventional methods in terms of speed of varietal spread, and genetic diversity.

## Concerns for Link Between Seed Systems and PPB

One of the concerns of PPB is the management of seed supply issues by formal sectors. Since different farmers will develop different types of varieties, issues of official release, seed production and their maintenance can pose a potential problem. However, this as such may not be a problem to farmers. Breeders and seed specialists tend to take a very technological view of their discipline and would like to see uniform, easily identifiable plots of released varieties. Varietal uniformity is designed for mechanized and high chemical input farming. There is no logic for following the same set of standards for subsistence farming.

PPB leads to the development of different varieties by different farmers. This system would not necessarily require a formal means of seed supply; seed can be supplied by the same local system already used by farmers. There is no doubt that this is a cost-effective and sustainable system of seed supply at local level. But it has some pitfalls too.

It is well established that the outflow of seed will decline as the distance from the source increases (LARC, 1995). It is a reality that farmer-to-farmer seed exchange of new seed is not as quick as anticipated. Sthapit *et al.* (1996) found that the spread of varieties occurs within the individual farm and then between the relatives within the village and then outside the villages within the family members. It may not address the equity aspect of benefit sharing amongst clients. Economically disadvantaged farmers' groups such as KDS indicated that they do not have access to new seed from the economically stronger groups.

We found that farmers exchange or sell new seeds outside the village after fourth year of the introduction. This is unacceptably long for new seed and could be the main problem if we depend upon the local system alone. If the PPB outputs are not to be limited to farmer-to-farmer spread (local system), then the economies of scale of the more formal or informal seed sector networks of CBOs and NGOs need to be exploited. Furthermore, the difficulties of farmer-to-farmer spread of open pollinated cultivars such as maize will add complexity.

The question is also raised that if the system of PPB works, then there will be an unmanageable number of varieties released that need to be handled by a formal institution. Existing seed regulatory frameworks will not be able to cope up with this additional responsibility. This is an unfair criticism because, even in the present system, the formal sector meets only 10-15% of the total national seed demand, and the rest is met by the farmers' traditional seed production and supply network (Cromwell *et al.*, 1993 and Joshi *et al.*, 1995). Our PPB experience from Nepal also suggests that there is no need to formally release all varieties, but a few exceptionally good varieties with broad domains such as Machhapuchhre-3can be considered for release. Farmers who have selected varieties for "niche" or " specific requirement" will constantly maintain and improve their variety in a continuous process of selection. There is no need to conduct multiplication trials to find out wide adaptation, this can be identified from the rate of farmers' seed demand, rate of spread within farm and between farm, and adoption rate.

The formal sector often deals with limited officially released varieties of major food crops, As a result, the contribution of formal seed sector to overall food security is small. In this context, the formal sector should emphasize the improvement of traditional varieties or farmers' varieties identified by PPB, and the responsibility for the modern high-yielding variety should go to the private sector. If modern HYV are not acceptable to farmers, they will not survive in the market.

It is also equally important that the successful case studies are demonstrated in different crops, different institutional setups and different ethnic and cultural settings to influence policy makers, as they are usually "hooked with the system culture".

The following are some of the major concerns:

- The formal sector is less interested in promoting PPB products because of the large number of location specific varieties which will be released. The small size of the seed market and high management cost will not provide market incentives unless the government provides a subsidy.
- Products of PPB are usually bulk seed. Farmers' varieties are much less distinct, uniform, and stable than formal sector-bred modern varieties. They will face seed certification and seed regulatory problems unless the system is refined for PPB products.
- Strengthening the local seed system is the only reliable way to link PPB. Slowness of farmer-to-farmer seed distribution and the inequitable sharing of benefits suggest the need for an alternative strategy for seed supply.
- The reform of seed regulatory procedures will be required to accommodate decentralized breeding and variety testing, release and registration procedures.
- There are strong institutional and policy constraints on legitimizing and institutionalizing the PPB approach. The role of GO and NGOs sectors in PPB is still a gray area.

## A Way Forward

Many governmental programs see PPB activities as contradictory and competing with rather than complementing their own efforts to strengthen and expand the institutional system of breeding and seed production. These problems are the root causes in the way of strengthening relationship between GOs and NGOs. They call for fundamental changes in attitudes, by creating awareness through training at all levels, especially at the level of research management and decentralization in breeding.

## Decentralized Variety Selection and Breeding

PPB will flourish if formal sector decentralizes PPB approach through both GO and NGO linkages. Decentralize here refers to the efforts of formal breeders to work with farmers in the improvement of their genetic resources within their complex, diverse, risky (CDR) environments and social conditions.

Initially, three levels of decentralization are possible: the first is at the national level from International Agricultural Research Institutes to NARS, and the second is possible by zonation within NARS, and the third, from NARS zones to NGOs. This third level should be the focus of the NARS' initiative.

The formal sector should encourage two strategies. First, strong formal breeding programs can be the main source of segregating lines or advance lines to NGOs for implementing location-specific PPB. The formal sector can assist the capability building of CBOs and NGOs and can monitor the spread of the varieties, and NGOs can offer the best materials to be nominated for multilocational trials for nation-wide testing. To avoid confusion and any conflict of institutions, the role of NGOs, CBOs and the formal sectors, including seed sector, need to be clearly spelled out.

Second, if institutional breeding is weak, then the formal sector should have a policy to encourage professional NGOs to carry out PVS and PPB. Such an approach means legitimizing PVS and PPB through NGOs. The main partners in PPB are clearly the farmers and farming communities. Their ability and knowledge of breeding have been generally undervalued, if not ignored, by professional plant breeders and researchers. As a result, NGOs can play a major role in this regard in mobilizing community support for PPB using materials from NARS activities. However, informal networking with NGOs and their CBOs will be essential, in order to share information and promising materials.

## Strengthening Local Seed Supply by Empowering CBOs

To address the aforementioned problem of the slowness of farmer-to-farmer seed supply and the equity issue, NGOs, Area Projects, and CBOs can multiply new seed as a income generation activity and sell locally or outside through NGO networking. This is possible where farmers are involved in PPB and CBOs and could organize themselves to explore these new avenues. In Nepal, local NGOs like LI-BIRD have initiated networking with different CBOs and NGOs to share the information from the PPB, and requests for seed have been accommodated. Farmers' groups are encouraged to multiply seed at local level and sell at a premium price. Breeders can also produce breeder seed from farmer-selected varieties to meet the minimum requirements of variety release procedures. Some of these seeds are distributed to neighboring CBOs for further multiplication.

NGOs, Area Projects and CBOs are usually more innovative and go for new initiatives. The contribution of these institutions in organizing seed production, disseminating new crop varieties and enhancing total food production is well documented (Joshi *et al.*, 1995). Besides Area Projects and CBOs, there are more than 4300 officially registered NGOs in Nepal, and this network can be explored to promote new crop varieties developed through PPB. This new initiatives may require institutional support and will get stronger as PPB becomes more successful and widespread.

## Informal Research and Development (IRD)

In most cases, few farmers have adopted improved cultivars, often because they have not been exposed to acceptable options to their best available variety or simply because they are not suitable for their conditions and need. To rectify this, farmers should be involved in the selection process from early stages, and the methodology should be very simple. In Nepal, at Lumle Agricultural Research Center, an IRD program was used to overcome the problems caused by a weak extension network that generally gave farmers poor access to new crop varieties (Joshi and Sthapit, 1990). Joshi *et al* (1995) have found this methodology is an effective approach to variety testing and evaluation in several crops. It is a kind of participatory variety selection (PVS), in which farmers are encouraged to select the varieties in their own target environment. The key is to identify similar niches and socioeconomic domains for the varieties. This approach will create a demand for seed for CBOs and help to identify suitable varietal domains.

Further enhancement in the dissemination of crop varieties through IRD is also possible. The recipients of successful IRD seeds may be motivated to supply handfuls of seeds at least to a few interested farmers (2-3) free of cost, and this can have large multiplicative effect. The approach may need regular monitoring for a few years in order to find out the effectiveness.

## Modification in Variety Release Procedures

The Nepal case demonstrated that the products of PPB can also be entered into the formal trials and that farmer-breeder selected variety can be officially released (Joshi *et al.*, 1996). The breeder can pick up the most widely accepted material from PPB and introduces this cultivar into multilocational co-ordinated varietal trials to test for wide adaptation and yield potential relative to the standard checks.

Witcombe *et al.*, (1996) suggest that cultivar release and seed production is still a very desirable end product to make the results of the PPB more widely available and gain the benefits of the large-scale seed multiplication of successful released cultivars. From the Nepal case studies, farmers have selected many varieties adapted to specific niches and conditions, but those varieties which perform better across locations are entered into the formal testing systems. There is a need to simplify testing procedures, varietal release and seed regulatory framework policy to speed up the process. For participatory approaches to be more cost effective, data on farmer perceptions, rate of varietal spread and demand for seed also need to be considered as legitimate by varietal releasing committees, rather than the almost total reliance presently placed on co-ordinated yield data from researcher-managed yield trials (Sthapit, 1995).

**Refining Seed Regulatory Procedures**

Questions are raised ong the need for varietal release for PPB products as this is mainly designed to facilitate the seed regulatory framework in the formal seed multiplication and supply network. Once a variety is released, NGOs, Area Projects and CBOs can legally multiply seed and distribute it via their own channel. The perceived advantage for variety release and registration is that the formal sector will take care of breeder seed maintenance, and production and seed distribution. Information and passport data will be officially documented and can be available in future.

**Policy and Institutional Issues**

The proposed approach may sound radical, but if it is institutionalized it can be expected to benefit national crop breeding programs by providing yet another method by which they can provide a service with the acceptable outputs to a large number of clients.

The process will also demonstrate that researchers and farmers can effectively collaborate early in the process to generate farmer-acceptable varieties. This is expected to give them mutual confidence in each other's capabilities and a better understanding, leading to a fruitful collaboration. As a consequence, the new approach will provide more food security to socially and economically disadvantaged groups of the community. Provided that national breeding programs appreciate the method and use it widely, the potential beneficiaries may also be the many farmers in high-yield potential areas of the country. The empirical evidences generated from the field will be a good reason to forge ahead with the simplification of the variety release system and the decentralization of the breeding program as well as the liberalization of the variety release system.

The institutionalization of changes is the most challenging issue. Policy makers, research managers and researchers themselves have to accept the institutionalization of the decentralized research process. If the success of these initial efforts is to be sustained, research management should ensure a congenial environment for field staff who work in difficult areas. This is often forgotten by policy makers or research managers, who have tried to replicate successful and innovative approaches from elsewhere.

## Research Issues

The evidence in this paper suggests that there is a need for more research on issues of seed diffusion across domains, ethnicity and kinship. If the domains of PPB varieties are large, then the problem of the need for too many varieties is reduced. Studies on the cause of slowness of farmer-to-farmer varietal spread versus formal means may also add new perspectives in this area.

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# ENHANCING FARMERS' PARTICIPATION IN PLANT BREEDING: SOME METHODOLOGY ISSUES AND CONCERNS

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## Introduction

Crop improvement and conservation in most countries of the world exist in two settings -- formal and informal. The formal setting links ex-situ gene banks and institutional and private industry breeding and seed production. The informal setting is where farmers and communities use and develop local varieties, integrating genetic conservation and utilization in dynamic systems of on-farm crop improvement and seed production. The formal system of breeding has been mostly geared to farming in optimal conditions and is highly dependent on external inputs and technology, the informal system, on the other hand, sustains productive genetically diverse farming systems in marginal and resource-poor environments. The two exist in parallel forms but are not connected.

*Institutional Breeding*

The development of high-yielding plant varieties coupled with good farm management helps raise crop productivity to high levels. Formal plant breeding has also been able to build into cultivated varieties a broad spectrum of resistance to diseases and pests as well as to soil stresses and toxicities. Varieties have also been selected for their efficiency in extracting and utilizing nutrients from the soil.

However, formal breeding has failed to adequately meet the needs and requirements of marginal environments. There are many resource-poor environments in which improved varieties did not express increased yield potential or did not satisfy other user requirements. This stems largely from the fact that breeding is mainly directed at increasing yield in more favorable environments. The cultivars are developed under conditions of artificially high nutrient levels and excellent water control. Pest problems are reduced to a minimum by an excessive use of chemicals. Many of the new varieties were selected for high harvest index, raising yields but ignoring other traits which are crucial for the survival of the farm households that cultivate them. Selections were frequently made on research stations with near-optimum conditions. These conditions are very different from the circumstance of small farmers.

*Farmers as Breeders*

Farmers have been found to employ their own taxonomic systems, encourage introgression, use selection, occasionally hybridize, make efforts to see that varieties are adapted, multiply seeds, employ simple cell-tissue culture techniques to produce new plants, field test, record data, and name their varieties (Salazar, 1996)

Farmers are assiduous if not opportunistic plant breeders, evaluating food plants as crops, as sources of family nutrition, and commodities. The existence of several hundred native potato varieties in the Peruvian Andes with a wide range of characteristics is due to the careful selection and subsequent evaluation by farmers of naturally occurring crosses (Prain *et al.*1991). Indigeneous people in the world-famous rice terraces in Ifugao, another Philippine province, contributed 530 out of 1870, or about 28%, of the Philippine rice accessions stored in the IRRI Germplasm Bank.

Farmers in the Mekong and Red River Deltas have developed and maintained local varieties that suit their adverse agroecological conditions. Traditional rice cultivars are grown on 1.42 million hectares of 1.92 million hectares devoted to rice cultivation in the Mekong Delta. Since farmers in Bohol province, Philippines like to eat red rice, they were reported as having produced red ricelines from white rice varieties released by the government. The farmers find it unacceptable that plant breeders call this "varietal deterioration" simply because the rices are nicer to eat (Salazar,1996).

The MASIPAG ( Farmer -Scientist Partnership in Agricultural Development) initiative in the Philippines on rice breeding effectively develops 88 advance lines suited to low external input conditions. The breeding objectives are set by farmers and the selection process is done by farmers in a number of trial farms all over the country. Farmers were given training on plant breeding and encouraged to breed cultivars adapted to their own farming system. Hybridization techniques had also been popularized with 28 farmer families in the town of Roxas in North Cotabato, Philippines.

Three farmers were able to follow the breeding methodology recommended by CIAT researchers and successfully develop advance lines from early segregating populations of the common bean over a 3-year period (Kornegay *et al.*,1995).

*Farmers- Breeders Collaboration*

Farmers participation in formal plant breeding spans a very broad set of activities along a continuum ranging from the involvement of farmers in helping plant breeders to develop the plant ideotype, to decision making about the release of varieties and seed production (Ashby, *et al.* 1995). Farmers were involved by plant breeders in planning and in decisions on what to cross, in line selection from bulk populations provided by breeders and in the final stages of variety testing or screening of breeders' lines (Berg, 1995). They participate in on-station progeny trials and variety trials of pearl millet (Weltzien *et al.*, 1996) and in the evaluation of 10 parents and 18 F2 populations of the common bean (Kornegay *et al.*, 1995). Farmers' involvement in the evaluation of advanced lines, whether in breeders' nurseries, on station, or in multilocation varietal trials on-farm, is increasingly recognized as a useful way to generate timely feedback to breeding programs about the potential acceptability of new materials (Ashby *et al.*, 1995).

Enhancing farmers' participation in plant breeding requires addressing farmers' priorities, incorporating their ideas into the breeding agenda and building on their knowledge of the crop and the environment. It entails the adoption of innovative breeding approaches, the use of breeding methodologies that farmers can understand and easily put into practice, the use of locally adapted germplasm, and the critical involvement of farmers in the whole spectrum of activities in the breeding process -- from varietal development to actual crop and seed production. The challenge is for the farmers to undertake most of the breeding work without losing the rigor of scientific research.

## What to Breed

Seed is an input in agriculture which for the most part, represents only a small fraction of the total cost of production, processing and distribution. However its impact goes way beyond its costs. The genetics of the seed determines in part where, when and how the crop is grown and the way it is processed and handled. The seed could be used to influence farming as a whole, particularly the type of farming where the resources in the hands of the farmer are extremely limited (Javier, 1984).

Farmers wanted crop varieties that were suitable or adaptable to their production system.The realities of farming proved that the conditions for growing crops are, most of the time, far from ideal. Crops are now grown in less and less hospitable environments. Farmers need varieties that adapt themselves to less than ideal or marginal environments. They need varieties that are responsive to low external input conditions. Most of the time, farmers could not make the conditions of their farm match the requirement of crops. Attempts should be made, therefore, to adapt crops to the environment. It can be done by choosing those naturally adapted to these conditions and/or by breeding and deliberately selecting varieties better adapted to the farmers' environment.

Varietal development should use complex, integrated farming systems as its starting point, instead of developing varieties that encourage monocultures. Farmers prefer varieties that will perform well under multiple cropping and integrated farming situations. Farmers are asking for varieties that can provide adequate returns when intercropped or rotated with their main crops. They are looking for varieties which could provide products and by-products for other farm enterprises and household needs.

*Hybrids vs Open-Pollinated Varieties*

Plant breeding emphasis should be put on open-pollinated varieties that farmers can reproduce rather than on nonreproducible hybrids. The norm in developing countries is for farmers to save their crop seed for subsequent plantings. They multiply and save seeds of either traditional or commercial varieties for their own use. They aim either to maintain the characteristics of the original plant or to continually improve the seed stock and, therefore, actually do a form of plant breding or crop improvement through selection.

Hybrids are highly uniform and generally expensive. They normally require high levels of external inputs to perform well. Hybrids lack the genetic variability to tolerate multiple stresses in marginal environments. The seeds are also not recyclable. The succeeding generations of hybrids are highly variable and different from the original variety.

Open-pollinated plants are produced through natural crossing and are composed of more variable plants within a population. Self- pollinating species have varieties with genetically uniform plants (purelines or inbreds). Unlike hybrids, and as in clones and open-pollinated varieties, purelines can be recycled for several generations. They could be made genetically diverse in the field by planting together different varieties or populations of the species.

*Uniform HYVs vs Diverse LAVs*

Conventional plant breeding strategies encourage breeding for uniformity. Varieties are bred for general adaptability. The introduction and widespread cultivation of these varieties destroys the diversity of local varieties. Before the introduction of the Green Revolution in the Philippines, farmers were planting thousands of different rice cultivars in about 3 million hectares of rice fields in the country. After the Green Revolution, farmers could count on their fingers the number of varieties being planted nationwide. This breeding strategy induces cropping systems that are ecologically unstable and prone to pest and disease outbreaks.

Farmers are not interested in wide adaptability. Their concern is stable yields on their farms and stable crop performance over seasons. They are not looking for the ideal variety. The evidence suggests that farmers want to manage an ideal range of varieties which answer their food system needs. Individual varieties are selected in terms of their fit, both with diverse ecological conditions and other uses. They are often allocated specific ecological niches where positive characteristics flourish and negative aspects occur less often (Prain *et al.*, 1991).

Farmers breed for agromorphological diversity, which is largely in response to use and preferences, and for diversity in the crops' adaptive characteristics. In genetic terms, this adaptation is not based on single characters but is multilocus with complex inheritance or co-adapted gene-complex (Eyzaguirre & Iwanaga, 1995). Prain *et al.* (1991) reported 39 criteria which farmers consider in their evaluation of varieties. Breeders can never hope to to satisfy this diversity in one variety. It is not only the numbers that are daunting. In some cases, the actual desired level of a particular criterion is variable.

*Elite Breeding Lines vs Locally Adapted Cultivars*

In plant breeding, the most valuable and basic raw materials are the genetic resources or germplasm. These consist of traditional varieties, elite breeding lines, introductions, mutants and wild species.

One major problem encountered in adopting the conventional process of varietal development is the rapid breakdown of the cultivar. This can be due primarily to the practice of crossing together elite lines which possess a narrow genetic base. The narrow genetic base decreases the alleles available among parents for the continued improvement of species. This condition of genetic uniformity increases the potential of being uniformly vulnerable to stress (Cayaban, 1990).

Solving the problem of the narrow genetic base requires a genetically diverse breeding population. A genetically diverse breeding population offers a high potential of introducing favorable alleles that may permit the improvement of the crop. The potential advantage of mating genetically diverse parents is that each may contribute unique alleles which, when combined together, may result in a superior individual. Traditional cultivars can provide this diversity if included in the breeding population. These cultivars are results of over a thousand years of natural and bulk selection, making them superbly adapted to their environment for long periods with no major change.

## Where to Breed

The yield of a variety under optimum conditions is a very poor indicator of its likely adaptability or acceptability. Breeders are generally aware of this problem and attempt to test their clones under a range of environments. Although, the adaptability of a clone can be evaluated through testing under variable farm conditions, acceptability will depend on a wide range of farmer evaluations. Farmers base their selection of varieties on a detailed knowledge of ecological and economic variation. They select varieties bases on their performance in different soils, in different climate pattern, and, in different levels of farm inputs, etc.

In marginal environments, genotype x environment interaction exerts great influence on varietal performance. The high degree of interactions make it difficult for plant breeders to identify cultivars suitable for farming systems that are characterized by high variability in social, economic, edaphic and biological conditions. In these situations, the best recourse is to direct selection in the target environments. Ceccarelli *et al.* (1995) evaluated their breeding materials in the target environments using farmers' agronomic practices. Kornegay *et al.*

(1995) included three farmer-managed farmers' fields as sites for evaluating 10 parent materials and 18 F2 crosses of the common bean.

In order to optimally capture the variability and locational attributes of the farming environment where the varieties are to be grown, varietal development should be done less and less in laboratories and research stations and more and more in farmers' fields. Germplasm enhancement and the improvement of farmers' genetic resources within their diverse environments and social conditions would result in the continued and succesful use of landraces and in the improvement of their social and economic value. Furthermore, farmers' participation in plant breeding under their own environmental and agronomic conditions will speed up the transfer and adoption of new varieties without the involvement of the complex, bureaucratic and often inefficient mechanisms of variety release, seed certification and production (Ceccarreli, *et al.*, 1995).

## How to Breed

Farmers' breeding is generally through mass selection techniques. The farmers select seeds from their own fields, either before or after harvest. Selection is based on a direct assessment of either the whole plant or the economic part of it. Observed variations are caused by the combined influence of environment and genetics. In self-pollinated crops like rice, farmers encourage introgression or the mixing of genes by mixed planting of varieties.

### *Multiple Crosses*

Kawano and Jennings (1983) suggested, as an approach to farmer-led breeding, the use of wide and multiple crosses among varied germplasm sources. Thousands of multiple crosses in one year in one location may be equivalent to natural crossing over many years in many locations. That, combined with modified bulk selection, may be a realistic approach to participatory breeding in marginal environments.

Genetic diversity in the farmers' fields, will be greatly enhanced if breeding institutions will release segregating populations and not finished cultivars. If local breeders and farmers access these heterogeneous, segregating and early generation materials and graft them on to local landraces, a plethora of region-specific and even village-specific cultivars, rather than just a few cultivars, will be made available to farmers.

### *Handling Segregating Populations*

One of the reasons why breeders are reluctant to give the farmers a chance to practice plant breeding is the complexity of handling segregating populations. There are several methods of doing this. The most widely-used are the pedigree and bulk methods.

The pedigree method is the most satisfying of the several procedures open to plant breeders. It permits the plant breeder to exercise his skill in selection to a greater degree than any of the other main methods. Record keeping in pedigree can serve the breeder better in his future researches. Thus, pedigree is best suited to those doing research work. However, this method of selection is falling into disfavor largely because of the prohibitive cost of accomodating the desired volume of segregants.

*Bulk vs Pedigree Method*

The pedigree method is too complicated to be readily adopted by farmers. Farmers only want to develop their own varieties by means of effective selection in a generally diverse population. This can be readily achieved in a bulk-developed population.

Genetic variability is better maintained in the bulk method. With the aid of natural and artificial selection, several genotypes within a population can survive. This is not possible with the pedigree method. Although every individual plant has an assurance of being represented in the next generation, only one or two of the best lines will be maintained. This is done primarily to avoid the selection of closely related individuals, whose probable worth is nearly identical. In the case of several lines belonging to the same population produced by the bulk method, their performance can be more flexible due to the interplay of natural selection, environment and genotype. Bulk methods provide more choices in selecting cultivars for specific environments (Cayaban,1990).

The bulk population breeding method would discriminate against genotypes with high harvest index because of their low competetive ability (Kawano and Jennings,1983). Ceccarelli, *et al.* (1995) evaluated segregating populations as bulks for three years, taking advantage of the large year-to-year variation in total rainfall, rainfall distribution and temperature patterns. The evolution of experimental design from the randomized complete block design to the lattice design and later to the lattice experimental design, progressively improved their control of environmental variability.

Sarkarung (1995) suggested the use of modified bulk and pedigree methods as a medium-term approach to participatory plant breeding. For the long-term approach, he suggested using the population improvement method. In addition, Sarkarung (1995) cited the use of anther culture techniques for the mass production of double haploid lines as the best alternative approach. This approach may be preferred by farmers since the double haploid lines are uniform but offer a wide range of phenotypic diversity from which farmers can select for their own conditions.

## Who Will Breed

Scientists have always been the ones involved in all phases of varietal development. The process commences at parental selection, through hybridization, selection and the setting-up of different yield trials to the release of cultivars. Alternative breeding strategies, however, advocate that farmers be given a chance to develop their own varieties.

### *Farmer-Scientist Partnerships*

One potential strategy is the creation of a farmer-scientist partnership. Scientists would provide the technical support while the farmers would do the collection, selection and hybridization. Farmers would also select parental lines for breeding and evaluate how far the new material fit the different segments of their farming system. Sarkarung (1995) outlines the following breeding process where farmers can participate :

i. Evaluation of segregating populations (F1 onwards in target environments);
ii. Practice basic plant breeding such as single plant selection and/or modified bulk in F1 and the following generations until the populations/ lines become nearly fixed;
iii. Evaluation of the material as lines through observation yield trials with or without replication;
iv. Organization of replicated yield trials of the selected lines by farmers in different key locations;
v. Multiplication of the seed of the selected lines;
vi. Recommendation of cultivars for release.

In addition, Sarkarung included the evaluation of a diversified set of breeding lines and the documentation of farmers' perception of cultivars traits/characters as activities in the later stages of the breeding process.

### *Skills Transfer*

Farmers should be given training and other technical support on plant breeding. They should be taught the basics of plant breeding. They need to be introduced to different plant breeding techniques. Farmers in the Philippines given training on hybridization were able to cross-breed different rice cultivars, select plants that were true to type and document the characteristics of the cultivars. They did this not only in community-managed trial farms with the guidance of professionals, but also in their own farm and by themselves.

Farmers manage the trial farms. They identify and study the cultural management of traditional rice varieties and improved cultivars. They select and purify promising crops. They conduct yield trials and do actual rice breeding. In all the activities, men and women have made equal contribution. It should be noted, however, that women appear to have more interest and skill than men in rice-breeding techniques. Young farmers were also encouraged to be more involved in the breeding work because they have clearer eyes and steadier hands.

*Access to Germplasm*

Scientists can provide farmers with access to institutional germplasms from a wider source. Farmers, on the other hand, can give scientists samples of local landraces that are still cultivated. They can also provide information regarding the outstanding characteristics of the varieties they are using. Scientists can carry out research, characterization, evaluation and the long-term storage of germplasms .

Enhanced by the documentation and understanding of its genetic composition and expression, the germplasm can be returned to farming communities. Farmers will have available to them enhanced germplasm of the type they have traditionally selected and bred. They will have access to such germplasm from a wider range of habitats beyond their own.

**Why Breed**

A review of recent literature in participatory plant breeding indicated that farmers' participation in plant breeding can be enhanced by focusing breeding activities on genetically diverse and locally adapted open-pollinated crops. Breeding activities should be done mostly in the farmers' fields and as little as possible in community-managed farms. Farmers should be given training on plant breeding. With adequate training and guidance from the scientists, farmers are capable of carrying out hybridization and of handling segregating populations by the bulk or modified bulk method. The scientific rigor of plant breeding activities in farmers' fields is optimized by the use of lattice and lattice experimental designs.

Participatory plant breeding aims to link formal -sector breeding with the farmers' breeding, selection and conservation of plant genetic resources. It also attempts to combine the best of scientists' and farmers' knowledge in research and development and it seek to maximize both agrobiodiversity and productivity (Eyzaguirre and Iwanaga,1995)

Participatory plant breeding is not so much about developing plant varieties. It is more about putting plant breeding into the farmers' hands.This is not only for the farmers to be able to develop planting materials according to their different agroecological conditions and according to their different needs, but also for them to be able to respond creatively to the changing ecological environments. In these situations, to wait for favorable morphological and agronomic traits derived from accidental introgression or mutations is, increasingly, not a viable option.The sooner the farmer takes the lead in crop improvement, the better the chances of plant breeding of becoming more relevant to sustainable agricultural development.

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# THE CASSAVA BIOTECHNOLOGY NETWORK (CBN): FOSTERING CASSAVA BIOTECHNOLOGY IMPACT FOR NATIONAL PROGRAMS AND SMALL-SCALE FARMERS

## Considerations as CBN members begin planning participatory research projects with cassava farmers and processors

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## Introduction

Cassava is the most reliable and affordable food source in over a third of the world's poorest countries. Cassava's harvest of starchy roots and high-protein leaves can be produced even on infertile soil with irregular rainfall, where cereals fail. Cassava is grown primarily by small farmers in unfavorable or marginal environments. In Africa and Amazonia, cassava is traditionally a women's crop.

In addition to its vital role in food security, cassava can be used as a low-cost, high quality raw material for small and large-scale enterprises whose products have growing markets. Initial processing must be done near the fields because cassava roots are bulky. This creates local employment and opportunities for rural entrepreneurs. Economic activity in cassava-dependent areas is stimulated, contributing to food security and the quality of rural life.

Cassava has another distinction: it is the only major world food crop neither grown in the temperate zone, nor used there in recognizable form. Yet it is in the temperate zone--the "North"-- where most technically-advanced countries are located. As a result, the communities who depend on cassava have been separated from research capacity by both space and tradition. For biotechnology to help cassava users, linkages are needed where they did not before exist.

## Why a Network Approach is Appropriate and Essential for Cassava Biotechnology?

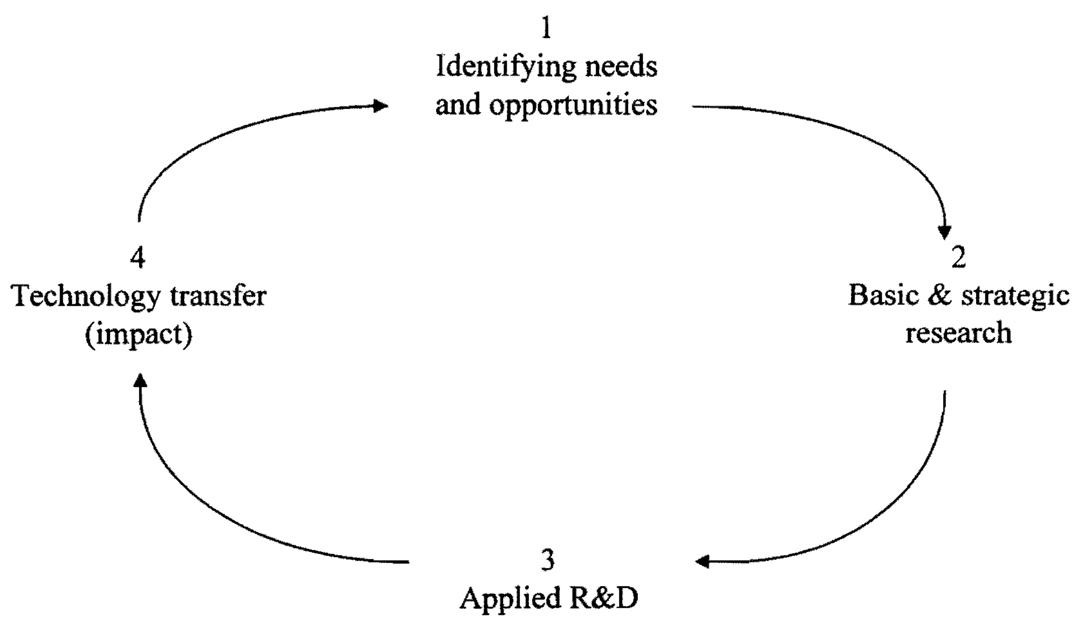
During the 1980s, CIAT, with IITA and a group of researchers in other development organizations, became concerned that cassava was being left out of contemporary crop improvement research. Cassava farmers, already among the poorest, stood to fall yet farther behind into marginal subsistence, as other crops captured new opportunities though advanced research. The research task involved in reversing this situation was too great for any one institution to accomplish alone.

CBN's founders saw a need and an opportunity. Although most investment in agricultural biotechnology research capacity is located in the North and focused on temperate crops, there is excess capacity which can be captured for an underinvested tropical subsistence crop such as cassava. A network could enlist the best labs in the North; make cost-effective use of existing investment in research; and stimulate research links between North and South, as well as stimulating biotechnology development in the South.

A network was needed to enlist international capabilities to conduct globally-relevant cassava biotechnology research around a common strategic agenda. Based on this conviction, CBN was founded in 1988.

CBN co-ordination activities for the past four years have emphasized the participation of cassava user groups in the assessment of cassava's research and development needs. Information exchange between biotechnology researchers and cassava researchers in national programs was also given high priority. CBN correspondingly expanded its activities with farmers and national programs in assessing needs, setting priorities, and transferring technology, becoming active throughout the full cassava R&D cycle. The linkages CBN has established permit strategic cassava biotechnology research to be correctly targeted and effectively transferred to benefit cassava users.

**Figure 1. The cassava R&D cycle (simplified)**



In the cassava research and development cycle (Fig. 1), the research of CBN members is a "Step 2 activity". Therefore, impact will depend on how well CBN is integrated in the R&D cycle. In support of a strategy of integration, CBN activities include:

- conducting farm and village case studies with cassava users;
- interacting with other groups working with cassava users, esp. small-scale farmers and processors and rural enterprise development;
- awarding small Grants in priority areas for cassava biotech research;
- organizing scientific meetings;
- planning and integrate biotech research projects with on-going cassava R&D world-wide.

In support of its strategy of creating linkages between disciplines and groups, CBN has awarded about 40 Small Grant Projects in the following areas:

- case studies with farmers and village processors;
- strategic research in developing countries and advanced labs;
- operational funds for applied and strategic cassava biotech research in national programs;
- transfer of biotech tools to developing countries;
- pilot projects with farmers and processing co-ops.

CBN members include about 350 active cassava biotechnology researchers, of whom about 200 (about 2/3) work in 26 developing countries, 130 in 13 developed countries, and 20 in two international centers. Members work in about 100 independently managed and funded activities or projects. A similar additional number of CBN members are national program cassava researchers in disciplines ranging from sociology and anthropology to agronomy and crop sciences, product development and marketing.

## CBN, Cassava Biotech and Farmer Research

Although CBN has been involving cassava farmers and processors in research priority setting for some time, their participation in research for development of cassava biotechnology applications is an area CBN is just beginning to explore. For some of the cassava biotechnologies, this is the result of the newness of the technologies itself. CBN's first collaborators in exploring participatory research will be the CADETs and Comités Campesinos fostered by CIAT Cassava Program and CORPOICA in Colombia; the COPAL farmer research committees fostered by CNPMF/ EMBRAPA, Brazil; and NARO, Uganda with its collaborators Vision Teruda, Action Aid, and World Vision. Biotech tools available for use include:

- tissue culture (available for some time);
- molecular markers (newly available);

- genetic engineering (recent breakthrough, about 5 years to first transgenic plants ready for participatory evaluation).

There are two stages of small-holder farmer/processor involvement relevant to CBN.

1. Participatory needs assessment

   Some experience with participatory needs assessment methods exists. Two questions, unrelated, require solutions. Both affect the direction of research for maximum beneficial impact in rural areas.

   i. How to explore "What if...." options ("wild ideas"), without using leading questions?
   ii. How to synthesize results of participatory needs assessment over locations and years, to provide robust information that can be used to plan medium- to long-term research?

   An example is CBN's experience in the Lake Zone of Northern Tanzania. This area was visited three times, and met with very different farmer priorities:

| | | |
|---|---|---|
| COSCA farmer survey: | late 1980s | Mealybug |
| CBN village discussions: | 1993 | Drought |
| National Cassava Program participatory variety selection: | 1995 | Root yield |

   This was the same area, the same farmers, but different years. What is the message for cassava biotech research?

   Table 1 presents cassava research needs and opportunities identified by CBN from work with both farmers and researchers.

### Table 1. Cassava research needs and opportunities identified by CBN

**Frequently expressed needs of cassava farmers and processors:**
Planting material of desired varieties
High yield
Sustainable yield over time
Improved traditional processing (speed, safety, nutrition, flavor, texture)
Disease resistance
Resistance to specific insect pests (mealybug, borer)
Low cyanogen content (only in some areas)
Ease of harvest (root shape)
Multicropping suitability (range of plant architecture types)

**Potential opportunities identified by cassava farmer/processors:**
Better adaptation to marginal environments (drought and heat tolerance)
Enhanced processing quality (home and rural enterprise)

**Researcher-identified (or diagnosed) needs and opportunities:**
Delayed postharvest deterioration
Alternative HCN metabolism: HCN only in parts, or, "self-processing"
Substitute HCN with broad-acting protective compounds safe to humans
Green mite resistance or biocontrol
Enhanced root nutritional quality (Vit. A; protein?)
Mycorrhiza, biofertilizers
More efficient plant use of soil nutrients, esp. K
True seed ? (difficult to compare costs and benefits)
New products from cassava fermentation
Novel root storage compounds
Reduced water pollution from processing

2. Participatory research using biotechnology tools for technology development[14].

   CBN's major current concerns here are:

   i. Because of the high level of investment required for the use of biotechnology tools for variety development, this research presupposes accurate needs assessment
   ii. There is little or no experience with participatory methods using biotech tools.

   Table 2 presents some of CBN's chief considerations for participatory farmer research with these biotechnology tools for farmers. Other considerations will no doubt arise as project development progresses.

The experience of existing researcher-farmer teams, such as those participating in this seminar, will be invaluable in answering some of the questions below, some of which may already be familiar; and in bringing other issues to CBN's attention.

### Table 2: Potential farmer applications of biotechnology tools (for farmers, by farmers)

**Tissue culture**
Used for accelerated propagation of desirable varieties (a need often expressed by farmers).

*Manner of use by farmers*
Low cost in-vitro methods for village entrepreneur.
Practical? Debated!
Farmer-managed vitroplantlets for weaning into stake multiplication plots?

*If used by farmers, what changes from the present methods of variety multiplication?*
Shorter time lag to direct farmer control of the multiplication of new varieties (one year to get 0-20 vitroplantlets per village instead of five years to get 10 stakes).

[14] The comments in this discussion paper refer to technologies for crop improvement (variety development and multiplication). Postharvest processing methods offer a different situation.

Farmer observation time starts earlier in variety history.
Instead of tough sturdy stakes, farmers would manage a first generation of delicate plantlets requiring shade and water for some time (= inputs).

**Molecular markers**

A powerful scoring method for traits presently difficult to manage because they are polygenic, have high environmental interaction, or are expressed late in life cycle (Examples: yield, drought tolerance, postharvest deterioration).
Also, a new and precise tool for maximizing genetic diversity at any desired level of uniformity for one or several traits (i.e., cooking quality).

*Manner of use by farmers*

Farmer-technician collegial participatory breeding program.

*If used by farmers, what changes from the present methods?*

Requires identification of contrasting types, undesirable as well as desirable.
Requires understanding that the use of markers in selection is a second step after two-three years field testing to develop the markers; marker development populations per se may, or may not, contain potential selected clones.
Requires discard of large proportion of seedlings based on confidence in lab results. Experience with keeping full population ("selected" and "not selected") could be used at first so farmers can evaluate worth of the method.
Requires (for any breeder) close collaboration with a lab for marker visualization and data analysis; lab need not be nearby.

**Genetic engineering**

To provide novel variation for traits with little or no variation accessible through hybridization. Examples: starch quality, cyanogen metabolism.
For targeted study of biochemistry and molecular genetics of complex traits through precisely directed "mutations".
Examples: soil nutrient use, photosynthesis under stress, crop ecology of cyanogenesis. (Farmer biologists?)

*Manner of use by farmers*

User testing.
Initial lab-designed prototypes with novel characteristics: farmers and processors test under their conditions; provide expert opinion feedback to biotechnologists for refining the design.
Farmer-technician collegial participatory breeding program.
Useful prototypes: like any other new germplasm source, can enter participatory breeding program for crossing and/or selection.

*If used by farmers, what changes from the present methods?*

Requires interest in evaluating prototypes that may bear little initial resemblance to useful varieties; willingness to wait for improved prototypes to retest.
May require observance of biosafety protocols (perhaps minimal, because first stages would be handled on-station).

# THE ROLE OF THE USER IN SELECTING AND RELEASING POTATO VARIETIES IN ECUADOR

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## Background

Potato is a staple in the Ecuadorean diet and an important source of income for numerous farmers, retailers, and processors. Of all the crops around the world, potato is the most susceptible to pests and diseases, generating very high production costs. For example, in 1992 (a dry year), the estimated cost of applying fungicides to control late smut was US$ 2,324,427, a cost that could easily double in a rainy year.

Until 1990, potato breeding, a sophisticated process, was vertical, that is, scientists carried out research and passed their findings on to users. Because of limited user participation, technology often did not respond to demand.

## Objectives

Summarize the experience of the INIAP Potato Program in selecting clones with user participation by comparing the traditional system of selection and dissemination with the experiences of selecting and releasing potato varieties through participatory research.

Offer researchers of other INIAP programs better opportunities for making the participation of farmers and other users in the adoption of new cultivars more effective and timely.

## Assumptions

That participatory research can be used to increase the flow of information on potato research, and that this methodology is more readily accepted by farmers than the vertical type.

*The Potato Program's Breeding Activities before the Participatory Approach was Adopted*

Before the participatory approach was applied, potato breeding was a long and expensive process that took more than 10 years to release one variety, the characteristics of which usually reflected more the taste of the researcher that of the client. The Program's strategy was to establish trials to validate recommended technologies. Farmers provided plots and labor. Their participation was minimal as their relationships with researchers were vertical.

In the 1980s, international centers did not play an interactive role in the variety of potato clones on offer. Materials released did not have the characteristics valued by local markets, and therefore their success was limited. In particular, tuber quality presented several problems in the preparation of local dishes. The Potato Program therefore had to look for materials suitable for consumers, crossing local materials with others maintained in the Ecuadorean Potato Collection. Breeding, however, was time consuming, and feedback from experiment stations to the research centers was difficult.

*Adoption: Improved versus Native Varieties*

Even now, native varieties still rank among those most accepted by consumers because of their excellent culinary characteristics and because their market price is 25% higher than that of improved varieties. Of the improved varieties, INIAP-Gabriela, released in 1982, is the most outstanding. Although it now accounts for 21% of the national market, it took about 12 years to enter. The variety's acceptance is based mainly on its pink-and-cream skin. Other improved varieties, such as `INIAP-Maria' (much older), had a much slower commercial growth and did not respond to specific markets.

*Current Experience with Participatory Research*

The National Potato Program is now interested in identifying users' needs in order to offer solutions that can be adapted by production systems. Trials are carried out with farmers on new potato clones to assess early maturity, culinary quality, and disease and pest resistance. From the beginning, farmers provide the socioeconomic context, defining opportunities and limitations. They participate actively in the planning and execution of trials, evaluating and finally selecting the best alternatives together with the researcher. The continuous contribution of ideas and modifications through the comparison of varieties is a dynamic process.

The new breeding scheme clearly determines that farmers should participate in the early stages—when they provide broad criteria (through open-ended evaluations)—and in the final stages—when they give directed opinions (ranking matrix) (Andrade et al., 1995). The new scheme is supplemented by culinary quality tests given to both rural and urban consumers. Finally, agroindustrial specifications are considered, which are well defined for characteristics such as dry matter content and reducing sugars.

## Techniques Used

The Proyecto "Fortalecimiento de la Investigación y Producción de Semilla en el Ecuador - FORTIPAPA" has used techniques such as (1) absolute evaluations in the early stages; (2) criteria-based ranking matrix in the second selection cycle, once a series of criteria has been defined; and (3) open-ended evaluations to record and classify the spontaneous reactions of farmers to a technology.

### *Changes or Adaptations*

**Mini-surveys.** These were used during the first year in localities with the least number of test clones, and were supplemented by absolute evaluations.

**Colored flags.** To conduct this evaluation, each farmer was given green flags to indicate selected clones and yellow flags to indicate clones that should be tested a second time. Materials not marked with flags were discarded. This technique was used mainly with those farmers with little formal schooling who spoke Quechua.

**Absolute evaluation.** The use of a scale of 1 (bad), 3 (regular), and 5 (good) to classify clones was not successful because the intermediate value caused indecision. The scale was therefore modified to that of 1 (bad), 3 (good), and 5 (very good).

### *Supplementing Participatory Research with Statistical Analyses*

Main component analysis was used to examine the information collected from farmers, and the correlation of qualitative and quantitative clone characteristics was also analyzed.

### *Results*

Tables 1 and 2 show the potato clones selected from two areas and for different types of users. The process began in the 1992/93 cycle.

## Farmers' Contributions

During the early stages, farmers contributed significantly to issues related to plant size, commercial production, response to diseases, and tuber color and shape. During the advanced stages, farmers indicated the commercial importance of, and market requirements for, tuber colors and shapes.

**Table 1: Number and percentage of potato clones selected per cycle since 1992, as a result of participatory research.**

| Cycle and locality | Clones evaluated (no.)[a] | Selected clones no. | Selected clones % | Observations |
|---|---|---|---|---|
| *1992/93 cycle* | | | | |
| Carchi | 319 | 42 | 13 | |
| Chimborazo | 24 | 8 | 35 | |
| *1993/94 cycle* | | | | |
| Carchi | 42 | 12 | 29 | |
| Chimborazo | 33 | 17 | 52 | Clones of the northern zone were included |
| *1994/95 cycle* | | | | |
| Carchi | E 4 | 2 | 50 | Varieties released |
| | L 8 | 4 | 50 | |
| Chimborazo | E 3 | 2 | 67 | |
| | L 14 | 8 | 57 | |

[a] During the 1994/95 cycle, early maturing clones (E) were separated from late maturing (L) ones.

**Table 2: Main reasons for selecting new potato varieties.**

| New varieties | Reasons |
|---|---|
| INIAP-Rosita | Tubers with pink skin and cream-colored flesh; high yielding (50 t/ha). |
| INIAP-Margarita | Tubers with cream-colored skin and flesh; high yielding (47 t/ha); good for homemade dishes (soups). |
| INIAP-Fripapa | Tubers with intensely pink skin and yellow flesh; high yielding (47 t/ha); used in agroindustries and for fresh consumption. |
| INIAP-Santa Isabela | Tubers with intensely red skin and yellow flesh; good yields (39 t/ha); used for fresh consumption. |

## Promoting User Participation in Breeding Activities

*Early Stages*

Open-ended evaluations help update researchers' understanding of user (farmer) requirements and complement participatory diagnosis. The number of clones evaluated should be 30.

*Intermediate Stages*

Absolute evaluations help specify user requirements (farmers, middlemen, consumers, and agroindustries). The number of clones evaluated should be 10.

*Advanced stages*

A criteria-based ranking matrix is used to detail users' criteria for the most important features of each variety and locality. Users are farmers, middlemen, consumers, and agroindustries. The number of clones evaluated should be 6.

## Making User Participation More Effective and Timely in the Adoption of Varieties

First, agreements were established between the Potato Program and farmers, according to the demands of end consumers, the main beneficiaries of research. The classical approach to systems research was thus broadened and complemented by the "chain" approach, that is, from the end consumer to the farmer, which is based on a precise qualitative and quantitative definition of the final commercial product. A potato variety profile was also defined to respond to (1) the quality parameters required for industrial processing, and (2) the agronomic and socioeconomic conditions in areas suitable for producing, on a competitive basis, raw material for industrial purposes.

Second, INIAP needed strong partners to provide the necessary credibility and continuity to the process. The Program, together with a processing company, tested several clones selected by farmers. Variety INIAP-Fripapa (formerly clone C-399) responded to identified needs, facilitating the formation of a farmer group, who supplied potatoes to industries and evaluated clones in their fields for several cycles. These farmers grew `Superchola' and `INIAP-Maria', the only varieties available for industrial purposes, even though these suffer severe disease problems, especially late smut.

Links between the different partners were gradually strengthened until an agreement was signed. The process, which included technical discussions, a feasibility study, the preparation of contracts, and negotiations, was guided by a team formed by a plant breeder, a nutritionist, the plant manager of a processing company, seed producers, an economist, and technicians from Instituto Nacional Autónomo de Investigaciones Agropecuarias - INIAP's technology validation and transfer units.

## Synthesis of Perceived Advantages and Constraints

### *Advantages*

Participatory research complements the scientific method. The incorporation of farmers' viewpoints into research and the broadening of researchers' understanding of farmers' behavior not only catalyzed the research, but also promoted the interest of users in the formulation and attainment of agricultural research objectives. Users thus increased their own ability to seek solutions and evaluate and apply research results to their condition, while accelerating the dissemination and adoption of technologies.

### *Constraints*

The technical team lacked sufficient expertise in participatory research to ensure impact. Researchers must be skilled in formulating timely questions that respond to prevailing information needs. Effective feedback to research centers was also needed.

### *Applicability of Participatory Research to the Potato Crop*

The Potato Program has already obtained four new potato varieties by using this methodology. The low cost of its application has also been verified, and benefits for farmers were clear, especially for those who discovered that they could test a small number of clones on their farms. Once farmers understand the selection process and recognize that they are solving a cultivation problem, they are able to keep their own records and obtain results. They also become responsible for disseminating successful new varieties within their communities.

### *Benefits that Farmers Receive by Participating in Research*

Farmers feel that research responds to their needs and priorities. Women are also given the opportunity to participate in the evaluation of clones, and their knowledge and expertise are taken into account. Links between different community groups are also strengthened, and the work of technicians is more effective.

### *The Participatory Approach Enhances Research*

Participatory research can help identify concrete problems that can be resolved in each production zone. Technological alternatives can be tested in environments differing from that of the experiment station. Research objectives can be adapted to the clientele's changing needs.

## Recommendations

1. All clones should be evaluated by different users: farmers, middlemen, fresh markets, urban and rural markets, and agroindustries.

2. Farmers who understand market dynamics and who have a clear concept of commercial agriculture should be included in participatory research to facilitate their participation in technology selection.

3. The selection pattern of several clones was closely related to variety prototypes, suggesting that efforts should be directed to acquire ideotypes similar to those cultivars.

4. Farmer group selection is demanding inasmuch as it can be biased by evaluators (also farmers) who try to impose their own criteria.

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# BEYOND THE FARM AND WITHIN THE COMMUNITY: ISSUES OF COLLECTIVE ACTION IN PARTICIPATORY NATURAL RESOURCE MANAGEMENT RESEARCH

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## Introduction

Natural resource management problems related to agriculture often transcend field or farm boundaries and can only be understood or solved if a broader perspective is adopted, i.e., a landscape or watershed perspective. Pest management is one example. The presence and severity of crop pests and diseases do not only relate to the management of the individual plot (the agroecosystem); they also depend on the way the landscape is structured in time and space in terms of plot sizes, intra- and interspecies diversity, habitat connectivity, etc. (Altieri 1987; Barrett 1992). Soil erosion is another transboundary natural resource management problem (Burel *et al.* 1993). Cropping practices, including the use of erosion control mechanisms on upstream plots, directly affect soil and water movements on the plots below. To tackle problems occurring in one part of a landscape or watershed, action might have to be taken in other parts. Conversely, to assess the impact on natural resources of specific management practices, implemented in certain parts of the landscape, measurements might have to be taken in other parts or from other crops or resources.

This interdependency makes natural resource management research different from the crop improvement research that typically focuses on plot-level effects and measurement of resource flows at the plot- or farm level. Also from an actor-oriented or participatory perspective, natural resource management research differs from crop improvement research. Crop improvement research typically focuses on the individual farmer, or perhaps a number of individual farmers seen as representing distinct types of farmers and farming conditions. In contrast, the temporal and spatial interdependency that characterizes many natural resource management problems implies that some form of collective action among landscape or watershed users to co-ordinate how the management of individual plots becomes essential in improving natural resource management. Collective action is here understood as action that emerges from a process of individuals deciding to voluntarily co-ordinate or concert their behavior, in this case natural resource management practices. A central issue in participatory natural resource management research, therefore, is how to foster and facilitate such collective action. This introduces organizational issues, including the issue of scale, into the participatory research agenda. This paper argues that the appropriate unit for collective natural resource management has to be found *within* the community: apart from being neither a biophysical unit showing the biophysical interdependencies as, for example, a watershed, nor a social unit, the community tends to be too large for mutual understanding and trust to develop among its members.

A second implication of the biophysical intèrdependency that exists within a landscape or watershed is the importance of involving the totality of users in efforts to improve natural resource management and to adequately appreciate the different views, interests, concerns, etc. that individuals or groups of landscape or watershed users might have on their own or others' use of the landscape. Failing to include some landscape users - or stakeholders - and their concerns might hamper efforts to improve natural resource management due to the biophysical interdependency. Methodologically, the challenge is how to identify stakeholders relating to a particular landscape and adequately elicit their concerns, interests, etc. Obviously, in most cases, there will be both internal and external stakeholders. In this paper, however, I shall only deal with issues related to internal stakeholders.

Measuring, or even observing, the effects of particular resource management practices at the landscape or watershed level is inherently complicated both for landscape users and researchers. This is the third implication of the biophysical interdependency that exists in time and space between the different patches of land and resources within a landscape, and it reduces the immediate incentives for landscape users to engage in efforts to improve natural resource management. The third challenge to participatory natural resource management research is to improve land literacy, i.e. helping people to read and appreciate signs of health (or ill-health) in a landscape (Campbell 1994), and to devise a process or a set of tools through which this can be done.

In the following, I shall deal in more detail with each of these challenges for participatory research arising from shifting the focus from crops to natural resources, from plot to landscape or watershed, and from farmers as individual actors to farmers as actors in a group. Rather than dealing with participatory research as a set of methods or techniques, I shall focus on the participatory research as an action-oriented process. On the one hand, the aim of this process should be to enhance landscape users' awareness and understanding of natural resource management problems and their ability to act upon these problems, drawing on their own as well as external resources. On the other hand, the aim should be to identify generic organizational process-oriented lessons or principles for participatory natural resource management to be applied elsewhere.

## Fostering Collective Action in Landscape Management

Rural landscapes, particularly in hillside regions such as the Andean hillsides or the East African highlands, tend to be managed by numerous individual landholders. Most of them own small patches of land which, together with other natural resources and perhaps day-laboring on neighboring farms, provide the major part of their livelihood. Decisions on how to manage land, water and other natural resources are taken individually and tend to be governed by concerns related to securing the household livelihood rather than considering the landscape and all the landscape users.

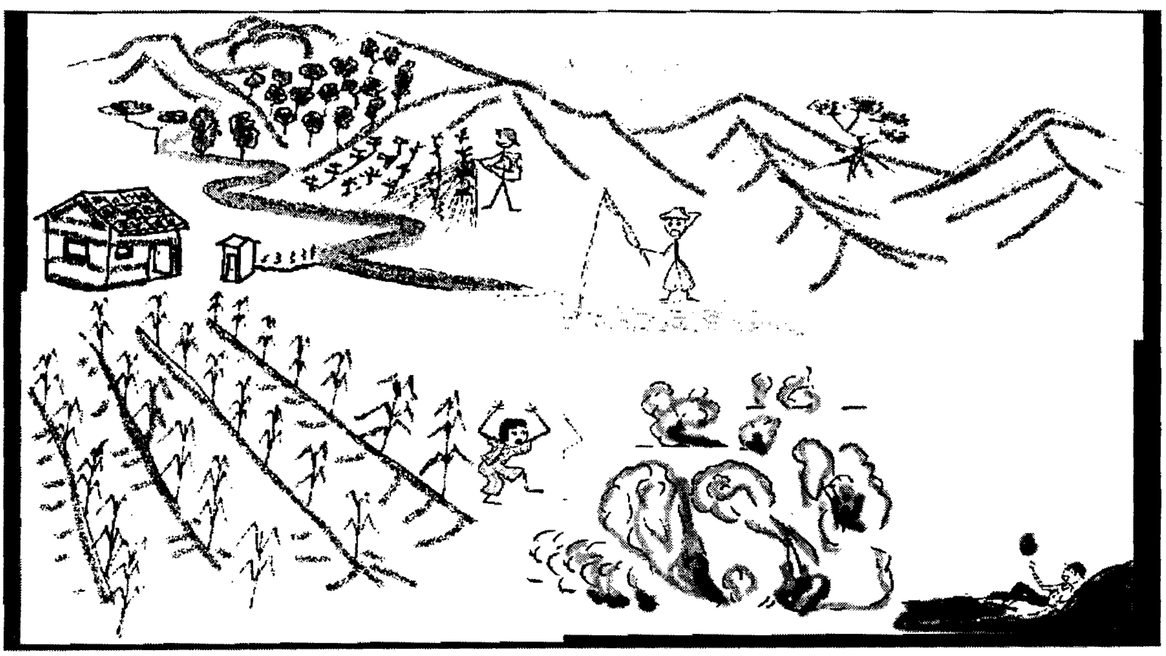
This does not only mean that landscape users lose sight of important landscape properties and that related natural resource management problems are aggravated there. It also means that opportunities for improving production are missed, even in the short-term.

A number of factors might explain this apparent mismatch between potential gains from collective action on the landscape or watershed level on the one hand, and its absence or inadequacy on the other: the fact that people tend to get used to the status quo and not question it; the lack of individual willingness or capacity to assume the transaction costs related to initiating collective action; and the lack of information about the attitudes and willingness of other landscape users towards collective action (White and Runge 1995). Altering this situation is likely to require a stimulus and input from outside. This is where the role of participatory research becomes important. Some key elements of this kind of process of change can be identified, based on experiences reported in literature as well as my own work conducted in the Río Cabuyal watershed in the Andean hillsides of southwestern Colombia.

Firstly landscape users must be encouraged, on an individual basis, to appreciate the need for collective action for solving the problems that they are currently facing by drawing their attention to landscape interdependencies. In the Gal Oya case in Sri Lanka where farmers organized in order to improve irrigation water management (Uphoff 1992), so-called institutional organizers were visiting farmers on an individual basis, asking about their problems with regard to irrigation and how they could solve these as individuals. This made farmers recognize the need for collective action and laid the ground for group meetings. In the case of Los Zanjones, a 44-hectare watershed in Río Cabuyal, Colombia, users were asked to analyze a drawing of a fictive landscape with a number of ongoing activities such as tomato cultivation and the associated application of chemicals; fishing; the incautious use of burning for land preparation, exposing neighboring fields to danger; the pollution of water by sewage outlets; etc. (see figure 1). Watershed users were specifically asked to make observations on how individual activities were affecting the others and to relate this to activities taking place in their own watershed.

Individual expectation of gains is an important precondition for collective action. However, as pointed out by both Uphoff, based on the Gal Oya case, and by White and Runge in their study of peasants engaging in collective action to control transboundary erosion in Maissade, Haiti, gains should not be interpreted in a strictly economic sense. Gains in terms of personal satisfaction derived from contributing to the improved well-being of others - altruism - (Uphoff 1992), or in terms of banking favors and building (or honoring) debt claims with neighbors (White and Runge 1995) often act as important motivations for individuals to participate in collective action.

The second element in fostering collective action is to provide an opportunity for face-to-face contact between landscape users, and thereby assume an important part of the initial transaction costs associated with initiating collective action. Again, based on the Gal Oya case, Uphoff describes how simply bringing people together created a public forum where before there had only been private communication. It facilitated new flows of information about what neighbors do and think, and created pressures for fairness, legitimacy, status and values that together prepared the ground for collective action. However, for such face-to-face contact to be practically possible and effective in building up mutual trust and understanding among landscape users, the number of users and, therefore, the landscape or watershed should be relatively small (Cernea 1988; Uphoff 1992; 1994), i.e. up to 20-30 users or families



which in a smallholder context would typically mean an area of less than 100 hectares. The appropriate unit for fostering collective action is therefore likely to be found *within* the community.

Yet, for many natural resource management problems such as pest management, 100 hectares will often be considered too small an area of intervention due to the related biophysical processes taking place on a wider scale. To reconcile these concerns with the importance of mutual trust and understanding among landscape users as a precondition for collective action, a more successful strategy would seem to be to link small base-level groups which have the benefit of face-to-face contact into a multitiered type of organization rather than to go large scale from the beginning (Uphoff 1994; Ostrom 1994). This, moreover, signals the importance of starting work in a landscape by addressing problems that are solvable or ameliorable at the small scale besides being important to landscape users. Once these have been some success at this level, it might be possible to embark on problems that require the co-ordinated management of larger areas and with larger numbers of users, by means of contacts with users in neighboring landscapes or watersheds.

## Stakeholder Identification

Collective action in landscape or watershed management is likely to have to take place in the context of diversity. Landscapes typically contain a multitude of common and privately-owned resources such as crop land, pastures, vegetation, animals, and water. Each resource has an associated complex of often conflicting interests held by stakeholders inside as well as outside the watershed. As an illustration of this diversity, the 20 families using the 44-hectare watershed, Los Zanjones, comprise four ethnic groups, two religious groups, commercial as well as subsistence farmers, land renters and land owners, etc. Due to the biophysical interdependency between the resources within the landscape, successful landscape management depends on the identification and understanding of different stakeholders and their resource use.

Scaling up from plot to landscape and from crops to natural resources implies that characterizing users according to dimensions such as resource endowments, gender, degree of market involvement, etc. is no longer sufficient. Many more aspects are likely to be in play such as the nonagricultural uses of landscape, the particular position of a plot, a crop or a practice within the landscape, the degree of attachment to the land, religion, ethnicity, etc. Moreover, the interests of external stakeholders relate to and influence how landscapes are managed, though to varying degrees.

Methodologically, the challenge is that the specific factors shaping the existence of different, particularly internal, stakeholder groups are likely to vary between landscapes and may depend on the particular issue within landscape management. This precludes, or at least complicates, *a priori* stakeholder identification based on a predetermined checklist of possible factors. Instead, stakeholder identification has to be contextual and calls for open-ended constructivist inquiry or exploration (Guba and Lincoln 1989). The constructivist inquiry consists of a process by which landscape users are invited, on an individual basis, to relate their concerns, ideas, values, and issues relating to the landscape and the management of resources taking place within it. Following each interview, central themes, concepts, ideas, values, concerns, and issues proposed by the respondent are analyzed by the inquirer into an initial formulation of the respondents' *construction*. After the following respondent has volunteered his or her perception, the themes suggested by the preceding respondent(s) are introduced and the respondent is invited to comment on those themes. The constant comparison and contrasting of divergent views in order to achieve a higher-level synthesis of them all, is a salient feature of constructivist inquiry (Guba and Lincoln 1989) and seems essential to any attempt to meaningfully identify and appreciate the existence of conflicting interests.

To ensure that *all* stakeholder groups are identified, landscape users are "sampled" according to what could be called a "contrast" or "maximum variation" sampling procedure, where each respondent after the interview is asked to nominate another landscape user who, in the respondent's view, would be likely to hold as contrasting a perception as possible from his or her own. The process of interviewing and soliciting nominations for new respondents is repeated until the information being received either becomes redundant or falls into two or more constructions that remain at odds in some way. Each of the emerging constructions indicate the existence of a stakeholder group. At this point, it is useful to bring together the "members" of each stakeholder group to discuss the construction and affirm its credibility as a joint construction of landscape management issues for that particular stakeholder group. These joint stakeholder group constructions form the basis of subsequent negotiation and the formulation of the action plans that are to take place between the different stakeholder groups identified within the landscape.

A crucial feature of successful stakeholder identification seems to be that it is based on interviews with individuals and departs from the individual respondent's personal concerns, etc. Asking groups of landscape users to identify different interests or stakeholders within the group or directly asking individuals to identify conflicts, would mean them distancing themselves from their neighbors in the presence of the group, something which is often not socially acceptable. A case in point from the Andean hillsides -- claims of homogeneity and agreement with respect to landscape management made in group sessions were later found to cover various types of disagreements, disapproval of others' resource use and even open conflict between landscape users, when individual interviews were held.

## Collective Landscape Monitoring

The difficulty of measuring or even observing the effect of particular resource management practices at the landscape level and the interaction taking place between different patches or species within a landscape or watershed, affects landscape users as well as researchers. For landscape users, it reduces the immediate incentives to engage in efforts to improve natural resource management. For researchers, it seriously questions conventional approaches to experimentation. Requirements of controls and replications at experimental plot level which are central elements of conventional experimentation and involve a relatively limited amount of data-collection, become virtually impossible to maintain in landscape-level research. Instead, large data sets on many landscape features related to the issue in question are needed from different landscapes thatare, at best, similar (Firbank 1993). This is costly.

The increased involvement of landscape users in the monitoring and analysis of spatial and temporal changes in key features within the landscape such as water quantity and quality, the severity of pest attacks, etc. might offer a practical solution both for landscape users and for researchers. For landscape users, it would not only improve land literacy, i.e. the ability to read and appreciate signs of health (and ill-health) in a landscape, and to understand the condition of the environment around them (Campbell 1994); it also would enhance the possibility of planning interventions in terms of scale and timing efforts, as well as prioritizing between possible alternative solutions (Ravnborg and Ashby 1996). For researchers, the involvement of landscape users in monitoring would provide a feasible way of obtaining the large and therefore expensive, sets of data required to properly analyze natural resource management problems at the landscape level.

As shown by an example from Australia, schools and landcare groups, i.e. groups of farmers working together to develop more sustainable systems of land management, gathered and analyzed tens of thousands of water samples from creeks, rivers, reservoirs, irrigation channels, and bores. Each school or landcare group analyzed its data and sent it to a central agency for processing. In return, they received a computer-generated overlay map of water quality in the whole district which served for interpretation, discussion, and the planning of further actions such as rehabilitation projects. Apart from enhancing land literacy, involving landcare groups and schools in water monitoring meant that a larger amount of data from more sampling points could be gathered than was conceivable for government agencies paying professional staff. (Campbell 1994). This point is even more pertinent in developing countries where the authorities responsible for natural resource management tend to be inadequately staffed and hence even less able to perform such data collection than their Australian counterparts (Ravnborg and Ashby 1996).

Many of the so-called rapid rural appraisal (RRA) techniques would be useful in such efforts to involve landscape users in landscape monitoring, particular mapping techniques and techniques that allow for the seasonal analysis of a particular problem or phenomenon. More emphasis will, however, have to be placed on devising procedures for *continuous* monitoring rather than the present one-off appraisal of the state of resources, and for compiling this information in a way that permits local as well as external analysis of the information. The tool developed by ICLARM for monitoring and assessment of small farm integrated agriculture-aquaculture systems, RESTORE[15], which combines participatory research procedures with computer-based analysis, might provide a basis for the development of tools to capture resource dynamics at the landscape or watershed level.

## Implications for Natural Resource Management

Moving from plot to landscape, and from focusing on crop production in isolation to crop production in conjunction with natural resource management, does not only raise issues related to social research centered around collective action as discussed in this paper, but also issues related to biophysical research aimed at understanding landscape-level dynamics and designing natural resource management technologies. Two issues stand out. The first issue, which has already been touched upon, relates to scale and how to move between scales. As

[15] Research Tool for Natural Resource Management, Monitoring and Evaluation

described in the case of weed management studies (Firbank 1993) and the control of water run-off (Burel *et al* 1993), observations made at one or a few points within a landscape cannot be extrapolated to the entire landscape due to the interdependencies existing between the different patches. Thus, for many natural resource management problems, it is necessary to take the landscape as the unit of study. This rarely happens today.

The second (related) issue is that of the role and mode of experimentation. Experimentation in a conventional sense is often practically impossible at the landscape level. Moreover, it may be unjustifiable to the extent that people depend on a particular landscape for the satisfaction of their present and future needs. Instead, the design of natural resource management technologies will increasingly have to rely on large sets of data collected jointly by researchers and landscape users in real-world landscapes and analyzed through the use of different types of multivariate statistical procedures (Jongman *et al.* 1995), geographical information systems and modeling. Real-world experimentation at the landscape level will, on the other hand, have to be limited to issues and areas where local landscape users are motivated and organized to undertake such experimentation through collective action.

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# EVOLVING AGRICULTURAL SYSTEMS AND THE DESIGN OF PARTICIPATORY RESEARCH

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## Introduction

There are a multitude of ways in which a particular agricultural landscape can be described, depending on one's purpose and perspective. The system perspective that I would like to take up is one that considers the dynamic, changing pattern of practices that farmers employ in their use of the land and resources they manage. I suggest that a theoretical framework that looks at this pattern as the outcome of a continuing process of evolution, and that borrows some of the concepts of generic evolutionary theory can be helpful to us, and for two reasons. First, it can throw up new insights into what we observe and what we understand of indigenous change in agriculture, and, in particular, why it proceeds slowly in some situations and much faster in others. Second, which comes to the purpose of this Workshop, such a perspective can suggest new methods, both analytical and practical, for researchers and other actors who wish to associate with and stimulate these indigenous processes. This framework is not comprehensive - it makes no pretense, for example, of explaining why farmers innovate in the directions they do - though it can usefully complement approaches that attempt to do so. Even on its own, however, it may go some way towards providing the "conceptual frameworks and methods that permit the description and analysis of local experimentation and information exchange" that Okali et al. (1994) see as essential if a working relationship is to be established between formal and informal research.

In what follows, I would like to briefly outline how an evolutionary perspective[16] can be applied to the problems of agricultural change and to the "design choices" that participatory research faces when it attempts to enhance the speed and efficiency of indigenous processes. I use efficiency here in two senses: the extent to which different types of farmers are reached and the thoroughness with which potential solutions are explored.

## Evolution in Agriculture

Evolutionary changes occur on at least two levels in agriculture (Table 1). On the first, natural selection operates on the plants and animals that are the objects of production, as well as the pests and beneficial organisms that are associated with them. People influence much of

16 Borrowing the language of biology, the perspective is a microevolutionary one, that focuses on the processes that generate change, at the base, rather than a macroevolutionary one that considers the larger patterns that these processes give rise to.

that evolution, directly or indirectly, but change still occurs through five basic, interacting processes. (i) Novelty is generated through mutation in the local population or via immigration from elsewhere. (ii) Selection acts on the variation that is thus created: organisms with different traits survive and reproduce with varying success. Those producing the greatest number of offspring are better represented in future generations. This demographic test is the heart of natural selection. (iii) Mechanisms of recombination, within and between individuals, give rise to new combinations of traits, combinations which together may constitute complex characteristics. The cycle is repeated, leading over time, and in principle, to a population increasingly adapted to local conditions. In practice the race can never be won, because conditions are continually changing. (iv) Consistent gains in adaptation are possible only because genetic inheritance perpetuates successful traits and is far more often faithful than it is corrupted by mutation. (v) These gains are brought to other localities through diffusion mechanisms, assisted by, or independent of, people.

**Table 1: Evolutionary processes in agriculture without formal sector involvement**

| | Natural | Social |
|---|---|---|
| **Generation of novelty** | Mutation<br>Immigration | Invention<br>Introduction |
| **Selection** | Differential<br>reproductive success | Testing<br>Comparison |
| **Recombination** | Cross-over<br>Hybridization | Exchange<br>Discussion |
| **Perpetuation** | Genetic<br>transmission | Learning<br>Teaching |
| **Diffusion** | Dispersal | Travel<br>Multiplication |

The second level at which evolution can be seen to operate in agriculture is the social. Although the application of Darwinian concepts to this realm has a long and often acrimonious history, an increasing number of scholars are finding that the basic processes, if not the underlying genetic mechanisms, can shed light on the evolution of concepts, tools and practices (e.g. Toulmin 1972; Durham 1992; Plotkin 1994). In many ways, agriculture offers one of the clearest applications of evolution because variation in the population of practices employed by farmers is generally readily observed and because what constitutes adaptation to local conditions is fairly evident, certainly more than, say, with respect to artistic concepts (Toulmin 1972). Using the same framework of processes as for natural selection, evolution in the social realm can be seen to involve the following mechanisms (Table 1). In what follows, I focus on indigenous processes of innovation, leaving to the final section the contributions of the formal sector.

*Generation of Novelty*

Novelty in an agricultural practice is the product of human invention, be it a simple change in the depth of planting a crop, or a more complex change, say in the rules by which water is managed in a communal irrigation system. Such novelty creates variation, the raw material on which selection can act. The rate at which novelty is generated is one of the key determinants of the speed of evolution. We still understand relatively little about what affects this rate, but several factors clearly play a role. The propensity to think up and, more to the point, to try out a new practice is affected by security of land tenure or of rights to the resources it requires. The ability to innovate and the direction this takes are also affected by what farmers know and understand of the natural processes at play in their fields and of market conditions. Generation is, in a broad sense, costlier and hence slower for complex and "bulky" practices, those that have a minimum scale, that require co-ordination among farmers or that yield benefits only after some time, than for simple ones.

*Selection*

The means by which farmers test and compare variant practices are still little understood, though increasingly studied. However, some generalizations appear justified. Firstly, farmers generally do not take on a new practice until they have tested it themselves. The decision to retain, abandon or modify the practice is seldom made in relation to the performance of a contemporaneous control. Performance of the new practice in relation to what the farmer expects to obtain, based on past experience, appears to be a common yardstick. Farmers are also keenly aware of what neighbors are doing and commonly compare their own practices with theirs. The size of the neighborhood within which farmers make such comparisons and from which they can access innovations if they appear superior is an important determinant of the speed and efficiency of evolution. If farmers are extremely stratified and isolated, by, for example, wealth, gender or caste, if their physical or economic conditions are highly heterogeneous, or if they tend not to move very far from home, the scope for comparison or for accessing innovations will be limited. Change on an individual farm will then be determined by the rate at which the farmer on her own generates new practices, which may be glacial.

Scale-dependent practices, for example, those related to resources managed collectively, can suffer a similar fate: farmers may live their lives within only one approach and have no experience of variation. In contrast, simple practices that can readily be modified by individuals will tend to have a larger neighborhood for comparison. Where physical or economic conditions among farms are similar, and communication and exchange between farmers relatively free, a promising innovation on one farm will quickly be noticed, tested and taken up by a large number of neighbors. Population genetics has developed the concepts of "genetic neighborhood" and "effective population size" to account for similar factors in the dynamics of genetically-determined innovations. Adaptation of these concepts, and of some of the related mathematical analysis, especially the underlying demographic approach, may help to make sense of the dynamics of agricultural practices. I return to this in a later section with some illustrations.

*Recombination*

Recombination processes play a crucial role in the development of complex innovations in agriculture, those that do not spring fully-fledged from an innovator's mind. Integrating fish culture into an existing farming system, for example, may require shifts in the planting dates of associated crops, changes in plant protection and irrigation practices, and possibly altered labor arrangements within households, all of which can be considered as elements of the "fish culture practice". Finding a productive and feasible combination of these elements takes time, certainly more than one season, and repeated testing.

There has been little concerted study of recombination in farming communities. However, exchange and discussion among farmers are clearly important. There is some evidence that the development of complex innovations is enhanced where farmers form cohesive, self-organized groups with a history of common action. On the other hand, where farmers have a low tolerance for the poor, initial results that are inevitable in developing complex practices, successful innovation is less likely.

*Perpetuation*

Agricultural practices that are found to be adapted to local conditions and preferences are maintained through learning and taught to others, in the same or following generations. The "soft" parts of resource management practices, such as rules for sharing irrigation water, may be enforced and protected by sanctions. The perpetuation of the material elements of innovation, such as seed or tools, is assured by storage and exchange mechanisms that operate at both the individual and community level. Innovation may require that both sorts of mechanisms be altered, which can affect the speed of change.

*Diffusion*

The spread of practices beyond the neighborhood where they evolved typically occurs through the agency of travelers or migrants who spread knowledge of new practices and disperse the seed of new crops or varieties. Local markets can be an important point for exchange of ideas and for the trade of seeds of new varieties or crops. These informal mechanisms may be supported, or ignored, by other sources of information and material, notably input dealers, extension agents, the seed industry and print and broadcast media.

## Implications and Applications

The evolutionary perspective can be of use to those engaged in participatory research in several ways.

Firstly, and most fundamentally, it provides a framework that can integrate disparate observations about the functioning of indigenous agricultural systems. It draws attention to the processes and mechanisms that underlie change within them, some of which, notably recombination, are often overlooked. In contrast to some approaches, an evolutionary perspective makes clear that indigenous innovation relies on more than experimentation *per se*. The perspective may help PR practitioners to see what they do in a new light, as an attempt to enhance evolutionary processes, and may suggest to them new ways of working. It may also help them to forge links with researchers in other areas of the natural and social sciences where evolutionary models are being used, with important possibilities for cross-fertilization.

Secondly, the evolutionary perspective provides analytical tools with which to diagnose the constraints to innovation within agricultural systems and to evaluate the impact of interventions. In particular, demographic methods can help explain why certain innovations spread quickly and others not at all, or why a given innovation spreads at very different rates in different environments. The speed at which an innovation spreads, positive, zero or negative, can be seen as the balance of two counteracting forces, "birth" and "death". A "birth" occurs when a farmer employs a new practice, or a group of farmers do so in the case of a collectively managed practice. A "death" results from a farmer or a group abandoning or possibly losing the innovation. Features of the physical and social environments, as well as the nature of the innovation itself, affect both "birth" and "death" rates. Box 1 illustrates the application of the demographic approach to an impact evaluation problem.

Thirdly, the evolutionary perspective suggests indicators with which to monitor the effectiveness of different methods or designs of participatory research. Here, the concern is not with the spread of particular innovations, but, more immediately, with the extent to which interventions enhance the underlying evolutionary processes. Earlier, it was pointed out that the evolution of complex and scale-dependent practices is likely to be slowed by difficulties in generating new options and by the need to recombine component innovations in order to create adapted, feasible practices. Box 2 illustrates the use of quantitative indicators for these two processes and shows how they can help in choosing between methodological options, in this case whether one works with loosely or more closely structured farmer groups. Other options might include measures to reduce the cost of experimentation for bulky, scale-dependent options (e.g. by creative use of research stations, or through interactive models or games). Success in enlarging the selection neighborhood, for example by enabling farmers or groups to visit colleagues some distance away, would be indicated by, among other things, the appearance in their fields of innovations originating in those areas.

**Box 1: The demography of novel bean varieties in Rwanda**

Researchers of the Institut des Sciences Agronomiques du Rwanda conducted trials with farmers on 3 bean varieties in 3 regions of the country. This occurred before formal institutions had begun to multiply or promote the varieties, so that farmers' assessments of their worth and the frequency with which seed was passed from farmer-to-farmer determined their rate of spread.

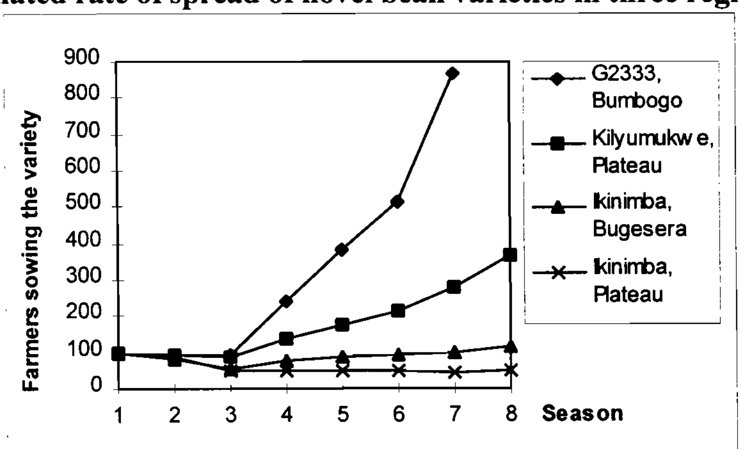
Researchers visited the original farmers at least three seasons after they had received the seed to assess whether they were still growing the variety and, if not, when and why they had abandoned it. Researchers also asked whether, when and to how many other growers the farmer had distributed seed. Estimates of survival probabilities and death rates were derived from the first set of information; birth rates were estimated from the second. Death rates in part reflected farmers' judgments of the varieties (which had been assessed independently). But deaths also occurred for reasons unrelated to a variety's characteristics. Farmers might lose a variety they valued due to flood or drought, or they might be forced to eat the seed. These involuntary losses occurred most frequently in the first seasons after a farmer received the variety when she was still growing it on a small area, and affected poorer farmers disproportionately.

Reproduction, resulting from a farmer distributing seed to a neighbor, friend or relative, usually began two or more seasons after the farmer received the variety. Once they started, distributions were often limited in number and restricted socially to relatives and close friends. Differences in birth rates among varieties were marked.

The rate of spread, the balance between birth and death rates, was estimated using a standard demographic model (Figure 1). Some varieties are seen to move hardly at all or even to regress; others spread rapidly. The favorableness of the agricultural environment and farmers' appreciation of the variety appear to be key factors. Note that the estimates of spread take no account of the degree to which different social groups may be left out of distribution. Other evidence from Rwanda suggests that the poor are often seen as unequal and undesired partners in seed networks. (From Sperling and Loevinsohn 1993).

The birth and death of resource management practices will be subject to other factors than are varieties. For example, the spread of a new approach to managing irrigation collectively will depend on the speed with which people learn of it by word of mouth or get to see it in operation for themselves, and then act on that knowledge. Achieving consensus on trying the new practice will likely take some time. A group may drop the practice because it doesn't perform satisfactorily or for unrelated reasons e.g. because of civil strife disrupts collective action.

**Figure 1: Estimated rate of spread of novel bean varieties in three regions of Rwanda**

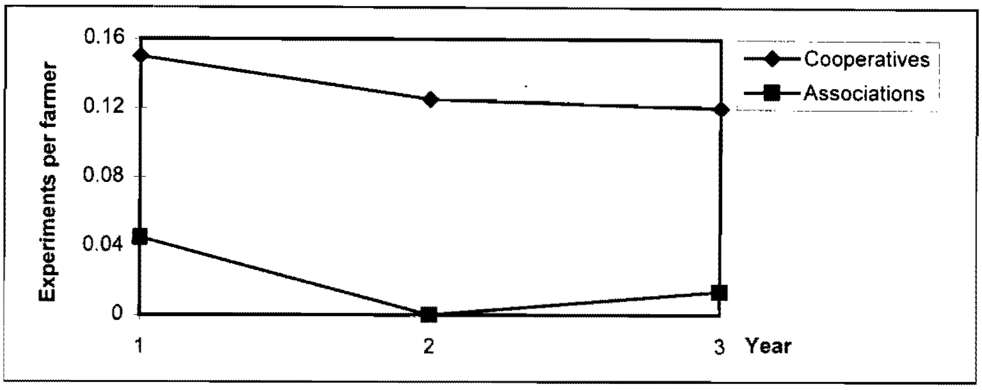


**Box 2: Innovation by farmer groups in Rwandan valleys**

A project of the Ministry of Agriculture involved researchers and farmers in the search for ways to intensify production in highland valleys in southern Rwanda. Discussions identified a number of possibilities, some from farmers' experience, others suggested by researchers. Among the latter were several on which no formal applied research had yet been conducted in the country. One such was the use of local *Sesbania* species as green manures. The trees were well known to farmers, but not the practice of green manuring. The basis of the research relationship was that farmers were free to try and test whichever option they chose and implement them as they saw fit. Researchers undertook to provide advice and seed for farmers' trials. But they stipulated that they could only work with groups, however these were organized. Four groups, of two types, agreed to work with the researchers. Two were "coopératives", formalized groupings which had been in existence for several years and which cultivated collectively, though some plots were assigned to individuals. The other two were newly organized, informal associations of field neighbors who collaborated as and when necessary. Researchers attempted to stimulate innovation by several means: through weekly visits where experiments were discussed; by organizing "traveling seminars" in which, once a season, groups visited each other to observe and discuss the experiments they were conducting; and by bringing farmers to a lower altitude station where experiments were proceeding in parallel.

Farmers rapidly found and adopted solutions to several problems, such as how to integrate rice into diverse farming systems. Progress was slower with green manuring. The idea of turning under a crop was unfamiliar and fertility was not perceived as a major constraint in the valleys. Initial trials also encountered numerous obstacles: germination and nodulation were often poor, drainage often impeded *Sesbania*'s growth and pest infestations were at times devastating. As Figure 2 illustrates, the rate at which innovations were generated and tested was low in both coopératives and associations, but relatively higher in the former, and it remained higher over 3 years. The coopératives persevered in the face of the difficulties, recombining ideas about when, where and how to grow *Sesbania* in order to produce a useful quantity of biomass. The close and long-standing relationships among the coopératives' members helped maintain a common purpose when the interest of some individuals waned. After the leader of one coopérative told researchers the group was no longer interested in *Sesbania*, they heard the next week, from another member, that the group still wished to pursue some ideas. It was this group that eventually identified what appeared the most promising option, in which *Sesbania* was sown between sweet potato mounds, then incorporated *in situ* or in neighboring fields. Maize yield was increased 30% in this way in one trial. The results suggest that self-structured groups with demonstrated cohesion and regular contact make more persistent and dynamic research partners than those whose members have little ongoing relationship. That advantage may be particularly important in difficult areas of natural resource management. Experience in the valleys indicated it was less significant in research on a more straightforward technology like rice varietal selection. (From Loevinsohn et al.1994).

**Figure 2: Experimentation with green manures by two types of farmer groups**




Fourthly, the evolutionary perspective provides a basis for *ex ante* assessments of the impact of different interventions. The processes of generation, selection, recombination etc. can be described in models which may then be used to simulate the effects of different assumptions and actions. One question that is frequently debated by FPR practitioners is whether and how one should attempt to improve farmers' experimental practices. The assumption is that by neglecting to employ a control, by implementing what are in essence radically incomplete factorial designs and by other sins, farmers are making bad decisions.

It might be said first that the importance of the question merits empirical investigation. In one of the few studies to examine the issue, farmers in eastern Africa were found to make good use of information, including some that researchers ignored. The conclusions farmers drew from a field trial correlated well with those of the researchers, but had greater specificity, as farmers took account of environmental variation that had not been controlled for in the experimental design (CIAT 1992). But even in the absence of data, models may be helpful to sharpen our thinking.

Assume the worst, that with their existing experimental practices, farmers are able to extrapolate correctly the performance of an innovation in a small test plot to that of the whole farm only 50% of the time (no better than flipping a coin), while researchers' practices enable them to do so 95% of the time. At first glance, there would appear to be justification in attempting to reform local practices. But on reflection, and a model can help to make this clearer, one can see that the existing situation may not be so bad. Farmers do not make their decisions in isolation. If my neighbor tests a new practice and rejects it, when in fact it is superior to his existing practice, while I, flipping my coin, correctly judge it superior and then proceed to use it over my whole field where its superiority is clear, both he and I can profit from the knowledge. Space does not allow a full development of this idea, but it can be shown that if a relatively few farmers, who make poor experimental decisions relatively independently of each other, are able to see the consequences of their decisions at full scale, they can, together, be more efficient than a very precise but solitary researcher[17].

Other issues, such as the question of how many farmers or groups a researcher should aim at collaborating with (is more in fact better?) might also be examined with such a model. It should be noted here that models of evolutionary processes are being developed by a growing number of researchers. The questions of "design" that they investigate relate not to real-life situations in nature or society, but to "genetic" or "evolutionary algorithms" that are used, on computers, to solve hard computational problems that tax conventional analytical methods (Holland 1975, Paton 1994). That seems a long way from the design of participatory research, but the models that are being used may, with some tinkering, prove to be helpful analogues of the evolution of farmers' practices.

Critical adaptation, rather than simplistic borrowing, must guide the application of evolutionary theory and methods to the problems of agriculture. But beyond being useful in our work, this framework may help to attract the interest of a wider range of scientists to participatory research. At present, participation floats several meters above the ground as far as many natural scientists are concerned. It finds no resonance in the theories and research approaches they learned, it was seldom used in the work of their teachers and mentors, and bears no relation to the disciplinary questions they assumed in their apprenticeship. Perhaps it is thought of as a convenience, but not something to take too seriously. By linking participation to one of the most successful theories of modern science and by providing it with a rigorous and, if necessary, mathematical basis with which to think about how one "does" it, an evolutionary perspective can raise the profile of participation among natural scientists and provide a wider bridge to the social sciences. Lack of stature is far from the only factor limiting the use of participation by research institutions, but it is not an insignificant one.

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# PARTICIPATORY RESEARCH: WILL THE KOEL HATCH THE CROW'S EGGS?

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*"To mobilize the masses does not mean to issue them with shovels and instructions; it means to fire them with enthusiasm, to release their initiatives and to tap their wisdom."*

*Joshua S. Horn*
*Away With All Pests: An English Surgeon in People's China, 1969, pg. 97.*

This paper describes an experiment in participatory research for sustainable development. The experiment relies upon certain crucial underlying assumptions. The traditional models of on-station development of technology and its transmission to farmers are no longer feasible, since high ecological variability demands niche-specific solutions. Local solutions developed by farmers themselves need to be identified and their scientific bases understood. The value-added scientific principles have to be shared back with farmers, who would then be able to develop technologies through their own research and experimentation, thus transferring `science' and not just technology (Gupta, 1989a & 1994b). Supporting and developing such experimentation is an important task for scientists and outsiders. Perhaps the most crucial challenge is for scientists to realize how they can participate in people's programs rather than asking how people can participate in formal outside initiatives.

The paper is organized in four parts. The introductory part deals with the context of participatory research and provides a brief description of the *Honey Bee* network which is based on the principles outlined above. The second part describes the process of participation and the various methods used by the network for participating in people's research programs. The third part presents a contingent framework of participatory research. The final section deals with some reflections on learning from women innovators and stresses the importance of identifying and transferring science in order to enable farmers to develop their own technologies.

## Context of Participatory Research and the Honey Bee Network

It is well known that the crow incubates and hatches the eggs of the koel (a species of cuckoo). But will the koel hatch the crow's eggs? Farmers have tried out scientists' ideas in the past. Will scientists now be willing to hatch the ideas of farmers? This is the direction in which participatory research will have to progress in the future. It implies a patient, persistent, ethical and accountable learning route to the development and diffusion of technologies. The need to find universally-applicable and quick solutions, often encouraged by the power of aid in the form of "participatory" methods like RRA/PRA, unfortunately militates against such an approach. The fact that hitherto insensitive and indifferent bureaucracies the world over find these methods legitimate, should itself have made everybody skeptical about them. We will not dwell further on this issue.

The participation of people in research programs aimed at developing sustainable technologies is considered inevitable today. This change in outlook, within less than three decades of the onset of the green revolution, is a result of the increasingly complex interactions between local socioecological and institutional conditions, and externally-induced technological change. In other words, the challenge technology designers face today is how to move away from delivering fully-tailored cloth towards supplying semi-stitched cloth which may be tailored by users themselves, keeping local specifications in mind. This requires both an understanding of the tailoring process on the part of the people, and an understanding of local preferences, criteria and specifications on the part of researchers.

Another reason for seeking participation is that it provides opportunities to scientists to recalibrate their scales of measurement and co-ordinates of perception. Perhaps what is more important is developing in scientists the ability to learn how to participate in the plans, programs, experiments and missions of farmers themselves (Gupta 1980, 1987b, 1995d). Ashby *et al.* (1987) had rightly criticized the excessive emphasis on the so-called diagnostic research methods that treated farmers as objects of investigation and in the process lost the farmers' voice. She emphasized that participatory research should involve farmers as co-investigators and researchers, and demonstrated, through farmer-managed trials, creative ways of understanding farmers' criteria for selecting varieties. Gupta (1987d), while describing the dynamics of homestead utilization by women, provided examples of the criteria used by poor women in the management of sweet potato seedlings, that had never formed a part of formal scientific research. There are many other examples, including the excellent research of Richards (1985, 1987), that demonstrate the need for scientists to participate in farmers' own research programs.

However, any process of collaborative learning can be meaningful and mutually enjoyable only when the classificatory schemes or taxonomies used by the partners are matched. It is not necessary to synthesize these taxonomies, but it is essential to understand the various vectors on which each knowledge system organizes information and generates patterns of knowledge. Does it matter in a dialogue between farmers and scientists in Peru whether the potato is distinguished by its local name, *Puka suytu*, or only by its Latin name, *Solanum tuberosum* (Vasquez 1996)? It does not when two classificatory schemes are mere tools to highlight the strengths of the knowledge systems on which they are based. But when one system's superiority is asserted, or when scientists use scientific language to mask their inability to understand the richness of the vernacular, there is a problem.

A second aspect of matching taxonomies is the need for formal science to realize that an indigenous taxonomy would be extremely rich when the variance in any phenomenon critical for the survival of that community is high. The community breaks down the phenomenon into a larger number of discrete categories, and characterizes each category by a different name. Thus, for instance, Eskimos have a large number of words for snow, and fisherfolk many names for varieties of waves. Each category symbolizes not only a pattern but also a theory underlying the classification and interrelationship of different categories.

Collaborative learning is not limited to just matching taxonomies. It raises the fundamental issue of the relevance of research. Scientists are "futurists", in the sense that they have the potential to shape the future (Latour 1983; Gupta 1987d). But by associating themselves only with particular user groups (for instance, better endowed farmers) or by following particular notions of "usefulness", issues concerning disadvantaged farmers may be pushed to the periphery. The question, therefore, is how can people affected by a research program influence the agenda and at what stage of the research. The concern for drawing upon people's knowledge while developing a research agenda is not new in the Indian context. In 1967, Dr.Y.P.Singh guided the first two postgraduate theses on indigenous knowledge. But the third had to wait till 1979 (Verma & Singh, 1969; Nand & Kumar, 1980). The need for ensuring relevance through building linkages between formal and informal research and development systems has been stressed by Biggs (1984) and many others including Chambers, Richards, Gupta, Ashby, Warren, Juma and Atte.

Finally, collaborative learning also implies that language does not become a barrier. Most research is published in English, with the result that local people do not get a chance to read and criticize. Sharing in the local language, at all stages of research, is an ethical dimension of participatory research as well as a means to achieve efficiency. That is what became the point of departure in the Honey Bee network.

*The Honey Bee Network*

The purpose of the *Honey Bee* network is to bring together people engaged in eco-restoration and reconstruction of knowledge about precious ecological, technological, and institutional systems. The network specifically aims at identifying innovative individuals or groups who have tried to overcome technological and institutional constraints with the help of their own imagination and effort. The innovations developed by such people are based on low external inputs, are ecofriendly and have the potential to improve productivity at a low cost. The values that underpin a network of such innovative people -- the spirit of excellence, critical peer group appraisal, competitiveness and entrepreneurship for self-reliant development -- would generate pressure for sustainable development that will counter the externally-driven and patronizing initiatives of the "people-as-victims" developmental paradigm.

The *Honey Bee* network brings out a newsletter of the same name in six languages in India (English, Hindi, Gujarati, Kannada, Tamil and Telugu) and in Zonkha in Bhutan. Offers have been received from Nepal, Sri Lanka, Colombia, Uganda, Paraguay and Mali for local language versions. The network is headquartered at SRISTI (Society for Research and Initiatives for Sustainable Technologies and Institutions, c/o Prof Anil K. Gupta, Indian Institute of Management, Ahmedabad), an autonomous global NGO, and extends to 75 countries at present.

*Honey Bee* insists that two principles are followed without fail: (a) whatever we learn from people must be shared with them in their language, and (ii) every innovation must be sourced to individuals/ communities with names and addresses in order to protect the intellectual property rights of the people. Such a process of learning and sharing implies that one has to realize that the boundaries between formal and informal knowledge systems may often be false. The informal system may have formal rules waiting to be discovered. The formal system may have informal beliefs or conjectures that may provide an impetus for further inquiry.

More than five thousand innovative practices, mainly from dry regions, have been documented over the last six years. Disadvantaged people may lack financial and economic resources, but they are definitely rich in knowledge. The label 'resource-poor farmer' is one of the most inappropriate and demeaning contributions from the West. At the same time, we realize that the market may not be pricing people's knowledge properly today. For instance, out of 120 plant-derived drugs, 74 per cent are used for the same purpose for which the native people discovered their use (Farnsworth 1988), implying that the basic research to link cause and effect had been done successfully by the people in a large number of cases. Modern science and technology can help by improving the efficiency of the extraction of the active ingredients or by synthesizing analogs (Gupta 1991a).

A second feature of this large collection is that people's knowledge systems need not always be considered informal just because the rules of the formal system fail to explain innovations in another system. The hazards of pesticide residues and their adverse effects on the human and ecological systems are well known. In the second issue of *Honey Bee*, out of the 94 practices reported, 34 dealt with indigenous low-external input plant protection methods. Some of these practices could extend the frontiers of science. For instance, some farmers cut 30 to 40 days-old sorghum plants or *Calotropis* plants and put these in irrigation channels in order to control or minimize termite attacks in light dry soils. Perhaps the hydrocyanide and other toxic elements in sorghum and Calotropis were responsible for the effect.

It is possible that private corporations may not have much interest in the development and diffusion of such alternatives which pass control of knowledge into the hands of people. However, an informed, educated and experimenting client always spurs better market innovations as is evident from the experience of the computer industry. Therefore, we do not see a contradiction between the knowledge systems of people and the evolution of market rules to strengthen and build upon them. However, such market model would have to be highly decentralized, competitive, open and participatory. *Honey Bee,* in that sense, is an effort to mold markets for ideas and innovations, but in favor of the sustainable development of high risk environments.

Of course no long-term change can be achieved if the local children do not develop values and a worldview consonant with the philosophy of sustainable development. Therefore, members of the network have also involved themselves in educational activities like holding biodiversity contests for school children. At another level, sustained change would demand a much higher scale of networking. The concept of Knowledge Centres/ Networks (Gupta 1995) was developed as a model suitable for the multilevel, multinodal and multichannel networking of individuals and institutions involved in sustainable development.

## How Do We Learn from People?

As stated earlier, the *Honey Bee* approach uses local solutions, developed by the people themselves in spite of technological and institutional constraints, as the basis for participation. Such a solution-augmenting strategy requires not just searching for local problem solvers, but also understanding their heuristics. The *Honey Bee* network has emphasized the role of innovative individuals far more than that of creative communities, not because the latter is less important but because the former has received much less attention in most Southern countries. The culture of compliance and conformity has also made many community structures less tolerant of local dissent, even if the latter is constructive. It is not surprising, therefore, to find that the innovations of a particular farmer are often not known even to his neighbors.

The methods that have been tried to identify and record innovations are listed below:

- survey of innovations (through students and innovators);
- competitions: (a) students (b) Government Officials;
- biodiversity contests;
- fairs and festivals;
- workshops;
- dissertations produced by students;
- participatory Institution-building initiatives;
- scanning of old literature.

### *Survey of Innovations*

**Survey through students.** Students of undergraduate and postgraduate courses in agriculture and rural development are trained during their summer vacations in identifying innovations. The training is very simple. The students are asked to narrate some of their own experiences which they found interesting, intriguing and inspiring. By underlining the ones that we find counter intuitive or less obvious, we convey what we are looking for. Since we communicate our message through metaphors and the students' own examples, communication becomes very efficient. The students then go to the villages, identify innovators and record their experiences. They also collect addresses of a few farmers who either know about the innovator and/or have fields adjoining the fields of innovative farmer. We write letters to these contacts later to have a first round of confirmation. Later, each practice is revisited by another student/field investigator to avoid any error in the process.

**Survey through innovators.** This approach has been used to identify innovative artisans, through a process similar to "snowballing". In some cases, the innovators themselves have traveled to look for others of their kind. This process has been very rewarding in identifying innovations in farm implements and soil and water conservation.

*Competitions for "Innovation Scouts"*

Competitions have been organized in two Indian states (Gujarat and Rajasthan) among students of agricultural colleges and grassroots-level government functionaries. Workshops were first organized to provide some background about the prior research and to illustrate many of the innovations that had been identified by village level workers. No reference was made to any of the so-called "rapid" methods for the simple reason that the ability to scout around for innovators depended far more on one's framework of understanding rural creativity than on any particular method. The entries sent in by the participants were evaluated and the winners awarded prizes. The innovators were also honored. One positive impact of such honoring has been the increase in the esteem that such innovators now command in their own villages.

*Biodiversity Contest: Identifying 'Little Eco-Geniuses'*

Biodiversity contests were organized among school children, and in some cases, out-of-school children and adults. The aim of these contests is to identify the ecological knowledge of children in order to recognize alternative knowledge systems in dry and forest areas. Children are asked to bring samples of plants they know about, on an appointed day. They are quizzed about the uses of the plants, the plants they know about but did not find, and other nature-related aspects. The first contest was organized in Madurai, India, by SEVA. Similar contests were organized in Kerala, Uttar Pradesh and Gujarat in India and in Vietnam and Bhutan. What was most remarkable about these contests was the fact that young children from very disadvantaged backgrounds showed an extraordinary ability to inventorize biodiversity and its local uses. Mahadev K. Sodha of Tadav village in Gujarat, 12 years of age, listed as many as 305 plants. Ankita Patel, a 11-year old girl of Valawada village identified 165 plants. Several lessons have been learned from these competitions, but one of them needs to be specially highlighted (Vijay Sherry Chand, Shukla & Gupta 1996, Gupta 1993, Gupta 1994a).

In one of the villages, Virampur, Karimbhai, a potter by profession but knowledgeable about local herbs, was invited to give away the prizes. After the function, we offered him some utensils as a token gift. To our surprise, he refused to accept the gift. He was willing to sell his pots. But in his role as a biodiversity expert, he would not accept any payment because he had never charged for his healing services. He is an extremely poor person and had to withdraw his elder son from school in order to manage his business.

Some of the other lessons are listed below:

- The ecological ethics of some of the poorest people were far stronger than one would assume. However, one cannot keep people poor in order to conserve diversity or the ecological ethics. It should be possible to maintain ethics without deprivation.
- The sacred dimension of one's belief system is compatible with the secular goals of the innovators. It is this blended culture which has to guide the spirit of enquiry of young minds.
- Little children have sometimes shown a far greater spirit of participation than adults. For instance, when a 12-year handicapped, out-of-school girl brought a single leaf as an entry it became obvious that winning a race certainly was not uppermost in her mind. How do we sustain this spirit when children grow up?
- Older boys seem to know much more about biodiversity than girls. Perhaps the additional household responsibilities of older girls restrict their biodiversity-related pursuits.
- Children from the so-called backward castes seem to know more about plants. Children from other castes obviously spend less time grazing animals or collecting forest produce.
- Children less than 12 years old have already traveled half the intellectual distance covered by the most knowledgeable adult in the community. The tragedy is that the formal education system does not offer opportunities to such children for furthering their skills in nature-related fields. Unless they learn 'A for apple, B for Boy, C for Cat', there is very little future for these children.
- Ironically, high biodiversity areas also show high rates of drop out from primary schools. Such areas are also high in poverty and the migration of males. The proportion of female-headed or managed households, consequently, is high. If we generate incentives which accrue only to those who are educated, or are male, or do not migrate, the poor may be left out.
- In one of the contests held in Kerala, children brought not just the lists of plants but also the seedlings. The school administration decided to give some of the seedlings as prizes and living mementos to the participants. The result was that shuffling of the local biodiversity took place. This is an experiment which has enormous potential to promote a people to people exchange of knowledge as well as diversity.
- In a recent modification, ecological indicators were collected through such contests. More than sixty indicators related to prediction of rainfall and other climatic parameters, disease and pest attacks, fertility of soil, performance of animals and crops, were identified. Many of these indicators would have to be validated through systematic observation, cross-cultural testing and scientific appraisal. What is important is that many of these indicators

embody wisdom encoded in the form of easy-to-interpret signals. This knowledge can blend very well with scientific knowledge.

*Fairs and Festivals: Message to the Masses*

We had not used the various religious and cultural fairs and festivals organized in different parts of the country to communicate the *Honey Bee* message till December 1995, when we set up a stall in a fair meant for trading donkeys, camels and bullocks. Many farmers visited the stall and purchased copies of *Lok Sarvani* (Gujarati version of *Honey Bee*). The stall also had a computer for demonstrating the database on innovations in the local language. Farmers searched the database for solutions to their problems. They also offered solutions which they knew about but did not find in the database.

In another fair organized in Junagadh, we displayed an innovative bullock cart developed by Mr. Amrutbhai Agrawat, an artisan. As many as 400 farmers showed interest in buying the bullock cart and registered their names for getting further information. Recently an agricultural university placed the first order for the cart.

*Lateral Learning Workshops*

**Participatory learning through peer group interactions.** We have been organizing workshops for innovative artisans, farmers and local healers. Scientists also usually attend. Before the workshop, reports on the innovations are circulated to the participants. During the workshop, innovators articulate the processes they followed and their difficulties. Other participants offer critical comments, alternatives or variations known to them. In a recent workshop of traditional veterinary healers, the participants themselves developed an agenda for conserving the medicinal plants they used.

**Traveling seminar.** Given the critical importance of farm implements in rainfed regions, we organized a workshop of blacksmiths and carpenters. Since most artisans do not make drawings of their implements, it is difficult for a lay person to understand the uniqueness of an innovation. We realized that there was no escape from traveling together to the work places of the artisans. Thus was born the idea of traveling seminar. The concept was used earlier by Jock Anderson in 1968-69 as part of his institution building efforts in the wheat breeding program in Bangladesh as a part of CIMMYT support to the Bangladesh Agricultural Research Institute (Gupta,1985a).

*Dissertations Produced by Students*

In an on-going experiment with the Mahila Gram Vidyapith, Nardipur, Gujarat, under-graduate students of dairy science have been writing dissertations on technological and institutional issues concerning indigenous veterinary knowledge. Different subjects like indigenous animal breeds, selection criteria, veterinary healers, institutions for the maintenance of pastures, breeding bulls, sharing animals and indigenous dairy products have been studied.

*Participatory Institution Building*

In most of the natural resource management research programs involving group action, one of the most obvious weaknesses is the lack of attention to institution building. Technological choices in the absence of institutional anchors may not be sustainable, particularly if they require periodic renewal and reaffirmation by the group. We have tried several approaches to institution building over the last six years:

- investing in local leaders;
- legitimization of local experts as gatekeepers for external resources;
- stakeholder involvement in the network building process;
- embedding new ideas in existing institutions;
- establishing (experimenters' network).

The last approach is the one which appears to be the most promising. One of the most controversial aspects of institution building is the definition of the boundaries of the group or collective. It has often been assumed, almost axiomatically, that the local village boundaries are the most suitable. However, an appreciative peer group is very important for generating, criticizing, nurturing and sustaining creativity and the long-term vision. It is usually difficult to find a critical mass of such experimenters in one village. A network like the *shodh sankal* provides the pulverization that any soil needs in order to make sowing possible. It also provides the optimal resistance to an idea as well as the critical appreciation for it. The meetings of this network are held in different villages.

*Scanning of Old Literature*

A sense of history is extremely important when blending different knowledge systems and ideas. An old indigenous reference generates more interest and involvement among scientists and farmers than any logical discourse. For instance, a lecture entitled "The Gospel of Dirty Hands" by a former cabinet minister and a man of literature, Dr. K. M. Munshi, very effectively communicates the principle of how middle class scientists and extension workers could lose their touch with the soil and the small farmers by not trying to soil their own hands. Similarly, an old book by Gangaben (1894) of Mansa in Gujarat, provides an excellent example of what woman's creativity can accomplish. She was a young widow when she wrote a book in 1893 that included 2080 recipes for self employment for rural youth. Many herbal pesticides, vegetable dyes, ways of storing grains are among the various ideas she wrote about. It is said that 1000 copies of this book were sold in just the first three days after publication. A reference to this book in our various meetings generates tremendous enthusiasm among field workers and farmers and communicates the need for documentation and dissemination.

Another advantage of old literature is that it generates humility. When one tries to assume a heroic role, it becomes difficult to be self critical. On the other hand, when one claims to merely extend a long tradition (say of participatory research), there is less resistance to the idea of collaborative learning. Way back in 1907, a book called *Fortune in Formulas for Firms and Farms* was published in North America. It continued to be published till 1943. This book was similar to Gangaben's in that it contained a large number of recipes for private or commercial use. There may be similar traditions in other societies and thus the first step in participatory research should be to trace the living traditions that are rooted in local culture and history. Instead of grafting on an alien terminology, concepts grounded in local philosophy, culture and traditions should be used as the initial building blocks. It is not our argument that local traditions can always provide sufficient scope for experimentation and innovation. However, there are always streams of resistance, innovation and experimentation which may be identified.

## Reciprocal Framework of Research: Contingent Perspective on Participation

We began with a question about whether the koel will participate in hatching a crow's eggs. It is now time to question whether such participation is necessarily superior to the participation of the crow in hatching a koel's eggs. Often, uncovering the farmers' own experimental approaches and heuristics may be sufficient to help them to redefine the problem and devise appropriate solutions (Gupta 1989c, Gupta 1989d, Pastakia 1995). But in some cases, farmers cannot devise solutions on their own. On-station research becomes necessary and farmers will have to merely participate in evaluating results or monitoring the experiments for any counter-intuitive observations. Normatively, we should not consider one form of participation superior to the other. Thus, farmers' participation in the scientists' own experiments need not necessarily be superior to scientists' participation in farmers' research. Both forms have their own advantages and limitations. In order to evolve a contingent framework, it is necessary to match the different methods of participation with the different approaches to defining the purpose of participation. The same method, say on-farm research, may not address all kinds of problems.

### *Defining the Problem*

It is a truism that the proper definition of a problem is half the solution. And yet, very often, we do not know whether our definition of the problem is correct or not. Let us take the case of weeds, which are considered to be a menace in rainfed crops. In the conventional definition, weeds are plants out of their place. But in nature, no plant can truly be out of its place. It is possible that we may not know the significance or role of a particular weed as a companion plant. For instance, the distribution of minerals in a field may help certain plants grow faster or slower. Thus, weeds may act as indicators of soil mineral properties (Hill & Ramsay, 1977). If we know the variability in the soil nutrient profile, we can follow precision farming which will lead to economy and efficiency in input use. Once the existing heterogeneity of nutrients is known, it is possible to study the reasons and take remedial action. Another way to look at weeds is to ask ourselves why farmers are selective in removing weeds. They obviously must be recognizing the allelopathic interactions of various plants. A good example is a weed (companion plant) called Sama (*Echinocloa colonum*) which grows on its own in paddy fields, or is cultivated in certain parts of the country. Why would farmers conserve a 'weed'? There may be several reasons: (a) it is an extremely nutritious grain suitable for consumption during fasting (b) a review of literature shows that it provides an alternative host for a few insects including leaf roller which do not affect paddy crop but get attracted to Sama and (c) some other ecological function which we are not aware of as yet. It is not without significance that farmers have conserved this weed through sociocultural mechanisms such as a particular festival, *Sama pancham*, when only grains like Sama are eaten. If sustainability requires a long time frame and a wide variety of heuristics through which our choices should be processed, then a strong case exists for understanding how farmers define a particular problem (Gupta 1981, Gupta *et al.*, 1995).

Termites or white ants are known to be a serious problem in farming as well as in households. However, like many organic farmers, Mulchand Haria of Kachchh district, an arid region of Gujarat, sees termites as a resource. His contention is that termites never attack green living tissue. They act as scavengers and attack only tissues that have died due to some disease or physiological problems. He has been nurturing termite mounds in his organic field. He does not even allow people to cross his fields because various beneficial organisms residing in this field may be disturbed. In certain parts of West Africa, pits are dug in the fields which are to be reclaimed. Various kinds of organic matter are dumped inside and termites introduced. Soon the field is converted into a fertile plot of decomposed organic matter (TASA system).

Once, during a discussion with some farmers on the reasons for growing different varieties of paddy in seemingly similar adjacent plots, a Bangladeshi farmer mentioned that one of the two varieties gave a better yield and fetched higher prices, while the other was good for consumption. The latter variety swelled in the stomach after consumption, giving a satisfactory feeling of having eaten. He suggested that the pangs of hunger were more debilitating than nutritional imbalances. The ability of grain to swell in the stomach may not have been a criterion or a problem to be studied by the scientists so far.

Let us take another example. Storability is a characteristic of sorghum which has not been given enough attention by those who have designed the protocol of germplasm characterization in ICRISAT (Bush and Lasey 1984). When one of us (Gupta 1991b) inquired about this characteristic from the former head of the gene bank (Dr. Mangesha) in ICRISAT, it was mentioned that it was not important. But millets and sorghum are not procured for the public distribution system because the improved varieties of these crops do not have good storability. Contrast this with a particular variety whose name in the Tamil language is *irungu cholam*. The word *irungu* is derived from *irumbu* which means iron. Obviously, if farmers chose to name a red sorghum variety having high storability in this fashion, the importance they attach to the storability character is evident. The etymological roots of the names of many other local varieties may reveal similar insights about germplasm characterization. Defining a problem is a process in which whatever effort is made will always appear inadequate. Yet it is an area in which we have made very little headway.

*Establishing a Causal Connection: Can Farmers Do the Right Things for the Wrong Reasons?*

Often people's knowledge is decried on the grounds that it is deficient in the area of cause-effect relationships. It is not realized that many modern technologies were developed with the causal basis for the effect observed remaining a mystery. Aspirin helped in reducing headache. Why it did so was not known till recently. Farmers in parts of Haryana in northern India grew coriander around the chickpea crop. They believed that it helped in repelling pests. At our suggestion, Pimbert (1989, personal communication to Anil Gupta) pursued research on this practice in ICRISAT and found that coriander did not repel the pests but actually attracted the predators (Gupta, Patel & Shah, 1986).

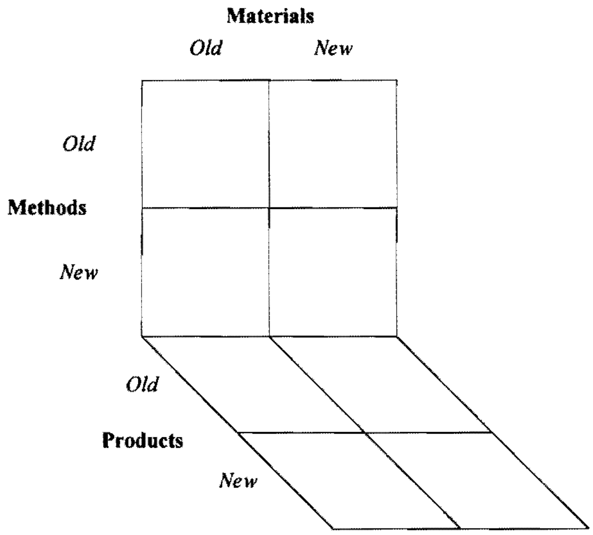
In the mid-fifties, paddy-growing Chinese farmers were suffering from the deadly disease, Schistosomiasis, which was caused by blood fluke. It affected 250 million people in Africa, Asia, Central and South America. Scientists studied the life cycle and found out that the snail was the intermediate host that helped in completing the life cycle of the blood fluke. Scientists communicated these findings to people through films, radio talk and other media. Once people knew about the habits and life cycle of the organism as well as the intermediate host, they devised numerous ways of checking them (Jousa, 1969).

In the case of the guinea worm, farmers could not identify the causal mechanism and therefore failed to control it. They did the next best thing, which is to cope. They developed methods of extracting the worm out of the body without breaking it. When scientists researched the problem, they found that people should not drink water from the ponds in which they washed their hands and feet. The worm spent part of its life cycle in the human body. By double filtering the water, the eggs could be screened out. Many more examples may be given of the role of participatory research, formal as well as informal, in understanding causal mechanisms.

*Widening Alternative Choices*

Primarily drawing upon the *Honey Bee* database, Pastakia (1996) studied grassroots innovators involved in sustainable pest management in order to understand their decision making processes. He identified two particular heuristics which were not reported in the formal scientific repertoire: (i) use of insect and plant material for repelling pests and (ii) increasing the growth of a crop to minimize economic damage by a pest instead of controlling the pest itself. The heuristics that the innovators used to derive such solutions included various combinations of materials, methods and products, each of which had a sustainability dimension determined by the renewability of the resources involved (Figure 1).

**Figure 1. Combinational heuristics**




*Source*: From an unpublished paper presented by Anil K. Gupta and Kirit K. Patel to scientists at Gujarat Agricultural University, Anand in 1994.

**Old methods, old material and old products.** Old methods, old materials and old products signify the traditional wisdom which may have relevance even for the contemporary context. For instance, *Virda* is an age-old technology for conserving rain water in a saline arid region with saline ground water. In a predominantly flat region, rain water gets stored in minor depressions or tanks. Within these tanks, the pastoralists dig shallow wells lined with frames of wood of *Prosopis juliflora* and grass. Just ten inches of rainfall provide sufficient fresh water which remains above the saline ground water inside the wells. The *virdas* are covered with silt and sealed. They are opened, one at a time, depending upon the need. The water remains sweet for two to three months, after which it turns saline due to the upward movement of saline water. This technology has enabled the pastoralists in Banni pastures to survive for several centuries. The season's rain may fall within a few days, hence the need for a robust, efficient and adaptive strategy (Chokkakul & Patel, 1994; Ferroukhi & Suthar, 1994).

In such a case, modern science does not merely help explain the functional viability of the technology, but also provides a basis for abstraction and generalization. For instance, once the properties of wood and grass, the pressure that the walls will need to cope with, the infiltration rate and the functions of the saline soil in holding the salts are explained, the search for other materials and methods for similar outputs may begin. There is very little advantage that the prior art of knowledge in modern science can provide while dealing with such complex questions of survival in difficult regions.

**Old methods, old materials and new products.** The hair which constitutes the mane of camels is known to be very hardy and resistant to corrosion. Traditionally, the pastoralists make different kinds of ropes, carpets and bags out of this hair. Once science figured out the use of these carpets as oil filters in oil refineries, a new product was developed from the old method and material. Similarly, sisal rope has been used in various activities, both for commercial and domestic purposes. It was found that these ropes can withstand corrosion better than any other material in the sea. Thus a new use for material grown in poor soils is generated. The processing of sisal is very painful because of the various tannins released into the water in which sisal plants are immersed for some time. When the fibre is taken out, these tannins cause blisters on the hand. Simple technologies have been developed to take the fibre out without hurting the hands. Modern science can blend in with the traditional methods while leaving other choices intact.

**New methods, old materials and old products.** In many of the cumin-growing regions, farmers had observed that the plots on the roadside were more productive than the ones in the interior. They figured out that the dust which settled on the plants saved them from certain pests and fungal diseases. Some other farmers observed a similar phenomenon near brick kilns. Dusting with ash or fine soil thus became a new method for controlling pest and fungal diseases in this crop. In many other crops, the use of ash as a dusting material is well known.

Similarly, the case of termite control using cut immature sorghum stalks in irrigation channels, reported earlier in this paper, opens up a new field of research. So far, sorghum breeders had been looking for landraces with a low hydrocyanide content. This innovation opens up the opportunity for selecting high hydrocyanide content sorghum lines. If this technology works in different parts of the world, dry farmers may very well grow a small patch of such sorghum for pest control purposes.

**Old methods, new materials and new products or uses.** Some innovative farmers have used a drip of castor oil (a tin box with a wick hanging over an irrigation channel). The oil drips into the water and spreads into the soil, adding luster to the banana crop. This drip is also used in other crops for soil-based pest control.

Examples of the other combinations may also be found. What these examples show is that farmers can be extremely creative in solving local problems. But the issue is whether their knowledge systems can be blended with formal scientific research. One block may possibly be the tension between the farmers' interest in solving the problem and the scientists' interest in developing a new theory. For instance, a farmer, Khodidasbhai, after reading about three different practices for controlling a pest in a local version of *Honey Bee*, used all three on the same crop, in the same season, but sequentially. It is quite possible that scientists would not attempt such an experiment in order to avoid a complicated design with confusing results. Learning to break old rules, which formal training does not easily permit, can be a useful purpose of participatory research.

*Institutional and Technological Cycles*

Institutional constraints can be precursors of technological change and *vice versa*. In fact the process may even be cyclical, with an · institutional constraint providing a spur for technological solutions, which in turn lead to an institutional innovation. Sometimes, both technological and institutional change may take place simultaneously. It has been argued that technology may be likened to words and institution to grammar (Gupta, 1991d). We cannot make much sense of one without the other. In the literature on participatory research, the interface of institutions with the process of technology generation has not been adequately addressed. Therefore, we will provide illustrations from the *Honey Bee* database in order to strengthen the case for modifying the framework for participatory technology development (Tables 1 and 2).

**Table 1. Technological triggers of institutional innovations**

| No. | Problem | Technological need | Institutional innovation |
|---|---|---|---|
| 1 | Pasture degradation due to trampling of grasses and grazing of seedlings by small ruminants | Either grasses should withstand trampling or they should regenerate in spite of damage | In Takuva village of Gujarat, farmers persuaded sheep and goat owners not to graze their animals for two months after rains when grass/ seedlings are tender |
| 2 | Locust attacks | Use insecticide, antifeedant or repellent to minimize damage | Farmers beat drums or bang vessels collectively to prevent locusts from settling on their fields |
| 3 | Silting of ponds | Mechanical desilting or catchment treatment | Collective action through religious or other motivation to manually desilt ponds (Saurashtra and Golden Temple) |
| 4 | Salinisation of soil in Gujarat | Soil reclamation and drainage | Pooling of private fields and agro-forestry with salt-tolerant species |
| 5 | Red rot of sugarcane and sorghum | Control of fungal spores in the crop residue | Burning of residues on a particular day in all the fields |
| 6 | Foot and mouth disease in cattle | Develop effective control agents | Quarantining diseased animals; separate grazing and watering |

The cases presented in Tables 1 and 2 show that technology and institutions are interdependent and trigger changes in each other. The changes may be simultaneous or may follow a sequence. For instance, the failure of village institutions to protect crops from grazing animals led to the innovation of seed treatment with butter milk. This treatment, however, led to another institutional change, the development of a sanction against the innovator, since there was a risk of the death of animals due to accidental browsing on the treated plants. Again this sanction may encourage innovative pastoralists to find out some way of identifying the treated crops. This sequence of constraints in one subsystem leading to innovation in another may continue till the limits of ingenuity are reached. The challenge is to determine whether one should adapt to a given technological constraint through an institutional innovation or evolve a technological solution to what may essentially be an institutional problem.

**Table 2. Institutional triggers of technological innovations**

| No | Problem | Institutional need | Technological innovation |
|---|---|---|---|
| 1 | Protection of crop from animals of migrating graziers | Evolving agreements between pastoralists and farmers to respect respective boundaries | Farmers treat seed of castor with butter milk which induces toxicity in leaves, requiring animals to be kept away |
| 2 | Protection of trees planted by individuals in common lands | Community action for protection of seedlings from grazing animals | A tree-planting entrepreneur devised machines to scatter seeds of tree species not touched by animals |
| 3 | Red rot disease of sorghum and sugarcane | Non-cooperation of farmers for burning residues on a particular day | Evolution of indigenous seed treatment for preventing disease |
| 4 | Fair distribution of water | Difficulty in supervising each other's withdrawal of ground water | In the Zuni community, sticks are provided to every user who cuts a particular portion after every use so as to keep a record of water used |
| 5 | Pooling of bullocks becomes difficult | How to generate incentives for pooling | Development of single-bullock drawn farm equipment |

In many villages in North Gujarat, farmers had to give up commercial hybrid seed production because of the failure of institutional support for isolation from other farmers. In such cases of participatory technology development, we may need to emphasize the institutional requirements. The technological response to this problem can be the incorporation of the apomexis gene in hybrids so that they can be grown every year like a self-pollinated crop.

In participatory research processes there is generally a tendency to underestimate institutional problems and to invest more resources in solving technological problems. The watershed research program is a classic case of such a bias. Many natural scientists do not pay attention to institutional dynamics and the management of common property resources. Institutional analysis may require an understanding of boundary rules, resource allocation rules, governance rules, conflict resolution rules, and conflict resolution rules, which is usually not in the province of natural scientists. Sustainable pest management, management of ground water as well as surface water, are other areas which require group action (Gupta, 1985b; Gupta, 1992; Sinha *et al.*, 1996).

A key factor in understanding institutional dynamics is uncovering the actual preferences *vis-à-vis* the articulated ones at the level of the individual as well as of the group. For instance, Sanghi and Rao (1982) and Sanghi (1987) tried to relax each of the constraints that farmers reported for not trying a dryland technology. When each constraint had been relaxed, and the technology was still not being tried, it became obvious that farmers were skeptical about the suitability of the technology. Sanghi and Rao (1982) provide a good example of how institutional dynamics can be facilitated by incorporating traditional knowledge in the technology development process. They found that sowing the crops with the pre-monsoon rains, as practiced by some farmers, ensured the efficient utilization of mineralized nitrogen, avoided pests like shoot fly and ear bug in sorghum, and ensured the timely sowing of subsequent crops. In summary, the understanding of the interaction between technology and institutions is an essential aspect of developing a participatory research program.

*Coping with Risk: Dealing with Household, Technological, Institutional and Cultural Risks*

In high risk environments, any participatory research approach can have relevance only if it can strengthen the existing risk adjustment strategies of the different classes of farmers. These strategies can be analyzed at household, technological, institutional and cultural level.[18]

**Household risk adjustment strategies:**

| | |
|---|---|
| Intra-household: | asset disposal, migration, reduction or modification of consumption, reallocation of resources among different enterprises, etc. |
| Inter-household: | labor, credit, land-related bilateral or multilateral contracts, informal sharing, gifts, etc. |
| Group or communal: | reliance on common property resources, group ploughing, sowing or other farm operations, like plant protection, drainage, purity of breed, group-level grain, fuel wood and resource reserves, etc. |

[18] Source: Gupta 1989e; Gupta, 1990; Gupta *et al.*, 1995.

Public Interventions: drought or flood relief, aerial spray for plant protection, distribution of seed or seedlings after natural catastrophes, infrastructural interventions

Cultural artifacts: myths, folklore, religious or other sanctions against private profit from community deprivation or for sustainable resource management, use of lunar calendar to synchronize farm operations, informal co-operation through cultural rituals regulating resource use

**Technological adjustments:**

Agronomic: dry sowing, early sowing, to break synchrony in the vulnerable stage of crop and virulent stage of pest, summer ploughing, cropping, contour ploughing and sowing, inter- and mixed cropping, mixed *aus* and *aman* sowing (in paddy), laddering and planking, sowing in set and furrow system, watershed technology etc.

Contingency: in many regions, the probability of some major treatments or risks can be anticipated and accordingly provided for through mid-course correction. For instance, relay cropping, thinning plant population after stress, mulching (it can be both, a regular practice or a contingency practice), devegetation

Salvage treatments: once a crop or some other enterprise suffers a shock or disturbance, technology may be required to recover from the losses. For instance, in flood-prone regions, cold temperatures at the grain feeling stage may cause sterility for which harvesting crop as fodder and ratooning may help; in flood-damaged areas, cutting and sowing of the stem of the surviving plants may help

Preventive treatments: several indigenous ways of seed treatment by organic gels and other materials exist to minimize drought and pest damage, border and trap crops for pest control, indigenous vaccination among animals

**Institutional risk adjustments:**

Spatial: the banks can lend to less risky villages, scientists can locate trials at less risky sites, the input agencies may locate distribution points in less risky regions because of larger demand

Seasonal: the lending can be constrained in the monsoon season, input supply may be erratic and inventory level low or nil in *kharif* season, the banking disbursements may be clustered around the financial year-end even if results are suboptimal

Sectoral: loans for nonfarm purposes, rainfed crops, small ruminants, long gestation investments like watershed treatments, etc., may be highly restricted. Credit for various purposes may be clustered even though there may not be a rational justification for such a portfolio

Procedural: high margins, insistence on collaterals, shorter repayment schedules (even though this practice may eventually increase the default risk),

| | |
|---|---|
| | multi-enterprise loans, linkage between investment and working capital loans, group guarantees, saving and lending groups, linking banking and technology |
| Background risks: | deposit and credit insurance and guarantees, crop and other enterprise insurance, failed-well subsidy |

**Cultural risk adjustments:**

| | |
|---|---|
| Collective action: | group-based management of resources such as water streams in hills, plant protection, watershed management, grazing land and common property resource management, rotating saving and credit associations and use of discount money for common property assets such as temples, school furnishings, pesticide sprayer, group norms for collecting fuel wood or roofing material on particular days in the hills |
| Folk rituals: | several folk songs, myths, stories, proverbs, are used to generate psychological assurance or social resilience in the local communities; attitude formation and generation of an eco-ethic is also facilitated by folk media |
| Institution building: | seneration of norms and values suggesting respect for common properties and participatory processes of decision making aid risk adjustments; pooling of bullocks, implements and other resources also facilitated by institution building processes |

It is obvious that one cannot incorporate the entire range of risk adjustment choices in any one program. However, it will be useful to jointly identify those risks that are important and agree on how to cope with them, without minimizing the potential for technological upgradation.

## Evaluation and Interpretation: Comparing and Contrasting Local Variability

Scientists can evaluate the experiments of the farmers and *vice versa.* Ashby *et al.* (1987) described ways in which farmers evaluated the potential of different varieties developed by the scientists. It is not just the judgments that one can learn from participatory exercises; the opportunity to learn about the criteria for making judgments is much more important. One of the methods that has been suggested for developing an empirical understanding of the local variance in resource use and coping strategies is a kind of manual discriminant analysis together with ecological mapping (Gupta 1987a, 1988).

The manual discriminant analysis (MDA) relies upon a simple premise, which is that, in any distribution, if we can compare and contrast the observation on the tails (i.e. extremes), we can understand reasonably well plus or minus one or two standard deviations. For instance, we can array the current resource-use patterns in a spreadsheet for each plot of every household. Having done that, we can look at the extreme values. Then, for instance, we can ask the five farmers who had sown earliest to explain individually why the five or ten such farmers who sowed last actually did so. Having asked about the reasons for a practice which is opposite to one's own, the frame of reference of the respondent farmer can be calibrated. After this, if we ask the same farmer to explain the reasons for his early sowing, we would probably get much more authentic information. This process may help generate hypotheses for further on-farm research or surveys. In a study on matching farmers' concerns, technologies and objectives (Gupta 1986b), it was found that, contrary to common belief, the criteria for specific choices such as sowing time in a rainfed crop may be determined to a greater extent by ecological factors rather than socioeconomic or cultural factors. In this study, an interesting determinant of the sowing time of mustard was the fallowing in the previous season, and not the access to credit or land or other inputs.

Similarly, ecological maps can help us identify the niches for different varieties. If the macro environment and local land races are closely inter-linked, by mapping one, say the varieties, we have mapped the other, i.e., the macro environment (Gupta, 1989a; Gupta, 1989b).

*Scaling up of Technology*

Just as different scientists have varying aptitudes for doing pioneering or repetitive research, different farmers also have a variety of attitudes to the development or scaling up of the technology. Some are content with whatever work they have done. Identifying the farmers who may like to scale up a technology need not necessarily mean identifying the privileged or big farmers.

*Participatory Breeding Research*

If we do not read the `book of diversity' embedded in local knowledge properly or adequately, we stand to lose much of the information available in nature and within local communities. Most breeders have not documented information regarding the providers of landrace resources or the culinary characteristics perceived to be important by local people. They often find it difficult to recall the selection criteria used by the local communities. This has resulted in inadequacies in the passport information sheets maintained in the gene banks. In the absence of information about providers, it would be very difficult to revisit the exact sites and to ensure that any benefits that may arise as a result of value addition are shared. SRISTI arranged an informal network meeting last year with scientists of GAU to correct these problems (Anonymous, 1995). We are keen to establish contact with other groups working on similar ideas.

In the case of animal germplasm, the situation is even more serious. Unlike crops, where a small sample of seeds, selected properly, may capture a large part of the variance of the population, a very large sample is needed in the case of animals to achieve the same result. Most ex-situ gene banks have very few animals of different breeds. The passport information sheets for animal germplasm are even more inadequate than those for plants.

The Honey Bee network has tried to address these gaps in the characterization of germplasm. The recent FAO initiative on developing DADIS (Domestic Animal Diversity Information Systems) is trying to overcome these inadequacies in a very participative manner.

**Building upon local knowledge: towards participative breeding.** The challenge, however, is how to make gene bank information accessible to the local communities in a form which is easily understandable and comprehensible. Also, information should flow back in such a form that breeders take note of people's knowledge. An important issue is the access of local people to material that would be useful for their own breeding programs. If communities and individuals have been developing distinguished landraces and animal breeds in the past, there is no reason why they cannot continue to do so in the future. The challenge of participative breeding is important for several other reasons:

- A very small proportion of the landraces available in a local gene bank is used in the breeding program of a crop.
- Ecological heterogeneity in rainfed regions and the location-specific differences even in irrigated regions (arising as a result of mineral deficiencies, changes in the water table, pest and disease regimes, drainage profile) require that breeding for local specificity becomes a paramount goal.
- Formal institutions all over the world are under severe resource constraints. It is unlikely that they will have the resources to expand on-station research facilities. Participatory on-farm research is thus inevitable.
- A large amount of improved genetic variability in the form of F7 or F8 generations/ advance lines is rejected today because of its inability to surpass the available checks (control varieties). Many of these lines may prove to be suitable for different locations.
- The selection criteria of farmers, which may be different from those of scientists, may provide sources of variability for improvement programmes. In a study on Matching Farmers' Concerns with Technologists' Objectives (Gupta, Patel & Shah 1986), we found that the harvest index in millets preferred by marginal farmers was much lower than that preferred by the bigger farmers. This realization has dawned on the institutional scientists only recently.
- Farmers might prefer technologies that reduce risk, not necessarily to the scientifically-acceptable levels of 95 per cent, but maybe to lower levels of 80 or 75 per cent, if the associated increase in cost is not too much.
- Participatory breeding also makes it possible to incorporate the women's perspective on farm operations, postharvest processing and cooking attributes.
- Farmers' innovations for the management of pest and disease, nutrients, weeds, documented through the Honey Bee network, could be screened using the farmers' criteria. This will help us in developing varieties which respond to nonchemical external inputs. It may also mean re-ordering breeding priorities in some cases. The example of cut stalks of sorghum to control termites was mentioned earlier.

- Farmers' own selections from local and external material have led in the past to the development of new varieties. This potential is grossly underutilized. Two examples would suffice: Thakarshibhai of Junagadh district of Gujarat suffered, as did many others, during the 1987 drought, one of the worst in decades. The government distributed groundnut seeds to counter the shortage of seeds. Thakarshi found two or three unusual plants in the crop he grew with these seeds. He selected them and developed a variety in which the pods are slightly curved, very compact and the grains quite bold. Each pod has two grains. The new variety was called morla, which in the local language means 'curved'. Several farmers have bought this seed. Similarly, Rajabhai, another farmer from the same district, had developed another variety from some unusual groundnut plants he had found.
- Many of the crops in marginal environments are grown as mixed crops. However, when breeders develop varieties, they often assume monocrop conditions first, and only later on try to generate intercrop combinations. Participatory breeding makes it possible for breeders to select under farmers' management conditions.
- It is well known that the economy of rainfed farmers is primarily dependent upon livestock. Yet, most of the crop varieties are screened on the basis of grain yield alone. By working with the farmers, scientists can get quick feedback on attributes like fodder quality, thereby making mid-course corrections possible.

What has been said above about the benefits of participatory breeding raises certain larger issues about the exchange of germplasm and conservation of diversity. The dangers of a narrow genetic base in the high-yielding varieties of paddy are well known. But such dangers are not new. The potato blight of the Irish Famine of the mid-19th century, and the corn failure in USA in 1974, are well-known examples. But the public response to such issues is always very slow. Even after the CBD, FAO Undertaking and many other national and international meetings on the subject, public policy remains very muted. Assuming that this situation is likely to change in the post GATT/ WTO environment, we must address the following issues:

- What are the biological, social and cultural bases of the exchange of germplasm among farmers? What is the role of farmers' knowledge about seed and soil-borne diseases, root exudates and their effects on seed specific microbial diversity, in triggering such exchanges?
- Seed exchanges across cultures and communities were part of the rituals in several communities. How has the erosion of these rituals in the process of modernization affected the exchange processes?
- The selection criteria for different crops have involved ingenious ways of incorporating agroecosystems and socioecological requirements into the selection process. The example of millet selection was mentioned above. How should the changes in the farming systems be related to the changes in the selection criteria?
- Will the restrictions on seed saving and exchange rights under UPOV 1991 affect the traditional diversity-creating processes? In which regions and crops are these restrictions

likely to have maximum effect (allowing for the fact that the restrictions will apply only to protected seeds)?

- How does the frequency of exchanges, within and among communities, depend upon the degree of variance in the gene pools of the respective populations? Can one hypothesize that, higher the variance in a given crop culture, higher will be the tendency for seed exchange? If so, can one use this practice as an index of the buffering nature of the population?
- Not everyone in a village grows the local landraces. Conservation strategies cannot be developed without understanding the nature and the extent of the buffering of gene populations in a given landrace, over space and time. Should one conserve, in one or two villages, all the ecotypes grown, or should a sample of plots in different villages spread over large areas be used? How should such a sample be selected? These questions have not been empirically answered. They are also relevant if we have to develop incentive systems for growers of landraces.
- Since much of the production in the high biodiversity and economically poorer regions is organic, compensation systems for landrace growers may include (i) organic certification systems in order to add value to the production and (ii) market research for generating demand? These steps imply that consumers will pay directly for conserving diversity. In any case, no long-term strategy can be developed for conserving diversity unless consumer demand for diverse tastes, shapes, colours and smells is generated and promoted by the elite role models.

A differential price incentive system could be tried. Thus, growers of landraces in a specified area could be paid the additional income they would have got if they had replaced the local landraces with high-yielding varieties.

The value addition in local varieties through decentralized units may also contribute to the conservation of diversity. The example of French wines, often made from grapes grown on very small and specific plots, is a rare case of market forces contributing positively to the conservation of diversity (Gupta 1991a).

- Can multimedia data bases on local diversity, for different regions and crops, be developed so that farmers could make selections from the available gene pool and undertake multilocation trials? Other approaches to achieve the same end may also be tried: different groups of male and female farmers may be taken to research stations to make selections from the ex situ gene banks; pursuing parallel selections by breeders as well as farmers and taking both the populations to advanced generation to see whether some distinct genetic advance is achieved by farmers' intuitive as well as explicit selection criteria, and so on.

Maurya (1988, personal communication to Anil Gupta) tried to give the excess seeds of the advanced lines, after matching their characteristics with the local varieties of paddy, another chance in the farmers' fields (it is a pity that Bottral and Farrington in a joint paper with Maurya tried to put far more method into this simple and innovative approach of Maurya's and distorted the actual process and its implications). He monitored the farmer-to-farmer diffusion of such seeds and assessed the suitability of different advanced line seeds for the farmers' microclimatic niches. The assumption was that such a variety of conditions would not be available at research stations. Unfortunately, due to the interference and opportunism of the donor agency concerned, a very useful approach was prevented from being fully developed. The selections of farmers from the material which the breeders had rejected, were perhaps not taken up for systematic trials at the research stations. This is an approach which does have merit and needs to be further developed.

- Studies have shown that breeders have no incentive for breeding varieties with limited potential for diffusion. In other words, improvement programs do not reward conservation or the augmentation of diversity. How should incentives be developed so that breeders are not rewarded only for varieties that diffuse over a large areas?
- To enhance variability in a crop complex, farmers in many cases plant different species of the same crop together to promote some kind of interspecific hybridization as shown in the case of paddy species in Sierra Leone (Richards 1985). Similarly, sometimes farmers realize the relationship between crop diversity and the so-called weed (or companion plant) diversity. In such cases, one could not consider conserving crop diversity without understanding and maintaining the diversity of companion crops or plants. How we should relate these two kinds of diversity is an underexplored issue.
- Variations in crop populations can be reduced or enhanced by various innovative strategies. Dr. Richaria has reported that, in a tribal region of Madhya Pradesh, a traditional healer, after following certain rituals, gave a particular kind of seed to different farmers as a sort of blessing. These seeds were to be grown along with whatever variety of paddy the farmers cultivated. It was later discovered that the distributed seeds were of a male sterile line which enabled a kind of hybridization in the farmers' fields. Dr. Richaria has also shown that by following the clonal propagation method, farmers selected the best plant and filled the entire field with the tillers of the same mother plant. This technique created a positive stress and enhanced the yield. The conservation of germplasm will require a careful study of such strategies of enhancing or reducing diversity in a field, and possibly increasing diversity in the populations.

There are many other issues in conservation, variation, selection, and exchange of germplasm which have not received adequate attention in the literature. Farmers' groups have been known to reward outstanding breeders of local varieties in farmer fairs in different parts of the world. Thus a culture of excellence does exist among the farmers. These issues need to form part of the agenda of participatory breeding research.

The foregoing paragraphs have dealt with a framework of participation that included defining the problem, working out causal links, examining the alternative choices open to farmers, combining the interplay between technological and institutional factors, strengthening risk-adjustment strategies, the issues of evaluation and interpretation, the question of the scaling up of technology and participatory breeding research. In the rest of this section, some of the models of participatory research experimented with by the Society for Research and Initiatives for Sustainable Technologies and Institutions (SRISTI) are described.

*Venture Capital Fund for Small Innovations*

The absence of a venture capital fund is a major handicap in testing out the small-scale innovations of farmers and artisans. An example of an innovation that has the potential to become commercially viable, and an experiment in supporting the development of the design of an innovative bullock cart are described briefly below.

***Case 1: Sowing Box***

*Amrutbhai Agrawat is an artisan in the village of Pikhor, district Junagadh, Gujarat. He has developed several innovative farm implements such as a wheat sowing box and groundnut digger. Most sowing equipment has a bottom part in the shape of a pipe which discharges seeds. The metering devices are located in the seed box. In dry regions, which also experience strong winds, lodging can be a problem in irrigated fields. Amrutbhai devised a box to spread the seeds in a strip. While the seed rate remains constant, the distance between the seeds is increased so that they do not fall one over another. With better root growth there is a more efficient nutrient uptake and also the crop does not lodge. In addition, if there is water stress, the crop is able to withstand it better, because of the stronger root network. He has also designed a groundnut digger with a flexible blade hoe which can be adjusted to change the distance between the two rows as well as to modify the depth to which hoe enters the soil to uproot the groundnut pods.*

***Case 2: Tilting Bullock Cart and SRISTI Venture Capital Support Fund***

*Amrutbhai had an idea about solving another problem that has remained unsolved for centuries. In most tropical plain lands, farmers have to carry the farm yard manure in a cart to a point in the field. After pouring the manure out in the field, farmers have to scatter it with the help of baskets. This consumes a lot of labor and time. He thought that if a modification could be made in the design of the bullock cart, a farmer could easily tilt the cart and distribute the manure slowly, over the entire field. This idea was worthy of support by a Venture Capital Fund (VCF). SRISTI, with the support of an IDRC grant, decided to experiment with the idea of VCF. A proposal was prepared and reviewed by two knowledgeable persons. And, eventually, the cart was developed. As reported above, many inquiries have been received and the first cart has been bought by an agricultural university. A large number of other ideas and inventions remain undeveloped or inadequately developed for want of VCF support.*

*Access to Information: Local Language Versions of Honey Bee*

Apart from the ethical requirement that cross-communication among farmers takes place, the practical spin-off may also be of help. A native American farmer, Janice Blue, after reading about a particular horticultural practice, did an experiment on her own. Similarly, a farmer from Puerto Rico, Judith von Riper wrote to us about the possible use of the bullock cart described above in her country. Apparently, there is no North and South when it comes to sustainable technologies.

*Bringing Experimenters Together*

Often, the idea of one farmer may be modified by another farmer, and operationalized by yet another farmer. For instance, Badribhai wanted to develop a bullock-drawn sprayer for herbal pesticide. However, we found out that such a contraption did exist. Without this cross-connection, he and his artisan friends would have wasted their resources. A workshop of artisans and professional scientists was organized to discuss what modifications could be made to the design of the pulley used by millions of women daily for lifting water from wells. It was realized that when women draw water they use up energy not only in lifting the bucket, but also in holding it in its place while taking deep breaths.

*Trust Fund*

In many cases, when grassroots innovators and biodiversity experts will not accept any monetary compensation, setting up trust funds provide a way of augmenting local experimental knowledge systems. Karimbhai, whose example was cited earlier, is one such innovator under whose leadership a trust fund was set up. Such funds can be of use when group-based experimentation has to be undertaken.

*Linking Private and Public Sector Research*

Many ideas developed by farmers may require further research. Organizations interested in value addition and the commercialization of technologies can help in this regard. Unfortunately, building partnerships with the private sector has not received adequate attention.

*Rewarding Innovators*

Compensating or rewarding people who have conserved natural resources, even while remaining trapped in poverty, has become an important issue, especially after the discussions on the Uruguay Round and the signing of the Convention on Biological Diversity. The desirability of evolving stronger intellectual property laws has been questioned by some people who perhaps believe that the continuation of a patronizing and protective regime is what the poor want to see. These people have no faith in the native genius and they argue that since we have never won a global struggle in the past, there is no guarantee that we will do so in the future. But those who have faith in the intellectual richness of local communities and individuals would like to use the evolving intellectual property regime to ensure higher returns for the innovators through a system of patents, trade secrets, contracts, licensing and so on.

We have been pleading for a global registration of local innovations, traditional knowledge and practices for the last several years (Gupta, 1991; Gupta, 1995c). The Third World Network also endorsed this idea, but restricted its application to collectives only. In contrast, we believe that individual innovators do exist, even in communities where communitarian knowledge is strong. These people would need to be compensated for their efforts. The proposed registry, International Network for Sustainable Technological Applications and Registration (INSTAR), would result in the following benefits:

- acknowledging individual and collective creativity;
- entitling innovators to a share of the returns from future commercialization;
- linking investments, enterprise and innovations -- the three corners of the triangle of entrepreneurship. This kind of networking will make it possible for small innovators to take advantage of the benefits of scale;
- regulating access to contracts by an autonomous authority that has a strong representation of local community representatives. This authority can keep copies of all contracts and monitor the sustainable extraction of resources;
- coding each entry in the register. This should include the postal code of the innovator, so that identifying the location of the innovator is possible;
- to begin with, the entries may only acknowledge the creativity and innovation. Later on, some of the innovations may be awarded inventor certificates or a petty patent that affords limited protection for a limited period of time;
- inventor certificates should also help in obtaining concessional credit and risk cover, so that the transition of the inventor into a producer or marketer is possible;
- the registration should also become a part of the Knowledge Network mentioned earlier. The Network can serve as a clearing house for various communities.

The registration system is only one aspect of a system of incentives and rewards to innovators. A broader framework of compensation would include the following elements (Gupta, 1995a, 1995b & 1994c): (illustrative examples are provided for each category)

Some of the ways of generating revenue for the various incentives are the following:

- a cess or tax on the sales of seeds derived from germplasm conserved and contributed by specific individuals or communities;
- a share in the turnover of commercializable plant-derived products, like herbal pesticides, veterinary medicines, dyes, antioxidants;
- a tax on the market arrivals in grain markets in the green revolution areas;

- a license fee to be collected from public and private sector companies for using germplasm still conserved by communities in backward regions, even if this germplasm is available in national and international gene banks;
- infrastructural investments in education and other basic needs.

There could be other ways of generating revenue. The crucial point is that one cannot expect poor people to conserve natural resources for ever and ever, while they remain in poverty.

**Figure 2: Scheme of compensation/reward**

| | | Nature of compensation/reward | |
|---|---|---|---|
| | | Material | Non-material |
| Compensation/ reward receiver | Individual | Patents<br>Royalty<br>License fee | Honors<br>Gate-keeping function |
| | Community | Trust funds<br>Risk fund<br>Insurance | Education<br>Curriculum reform |

**Learning from Women Innovators: Does Gender Make a Difference to the Nature of Indigenous Knowledge?**

This final section summarizes some of our reflections on the relationship of gender with indigenous knowledge, in the context of participatory research. These are tentative and cannot be treated as definitive. There are certain patterns in knowledge systems on account of gender, and there can be no doubt that the parameters of a technology that minimizes the vulnerability on account of gender and/ or poverty in the market place will have to receive greater attention while developing innovations.

It is a truism that women have much better grounded knowledge of the practices in which they are primarily engaged. Thus, seed storage, postharvest processing of grains, livestock hygiene and husbandry, the marketing of certain kinds of trinkets or farm produce, household recipes, are examples of this kind of specialization. Whether the knowledge so produced is affected more by the specialization or gender is not an easy question to answer. Two examples which illustrate some of the issues are presented below.

### *Making tubers round and storable*

*In Tangail district of Bangladesh, we (Gupta, 1987d) observed one woman who had set up a nursery of sweet potato on a small patch of land. She planned to transplant the sweet potato in land which she hoped to get on lease. In case she did not get the land, she would continue to grow the crop so that she could feed her family sweet potato when rice became difficult to get. While cutting the sweet potato vines, she was also de-rooting them at the nodes, leaving only one or two roots. Her reason for leaving only one or two tubers at each node was that this practice resulted in rounder tubers which had thick skins. The round shape was preferred by consumers and the thickness of the skin helped in prolonging the storage life of the tuber. These criteria were not incorporated in the selection criteria of sweet potato at either national or international research institutes. Obviously, the practice made a lot of sense and helped overcome some very specific constraints.*

### *Winter irrigation of arecanut through banana*

*Ms. Dilruba, an oilseed breeder, made a case study of women farmers in northern Bangladesh. She found a very interesting practice for providing moisture to arecanut trees during winter when there was hardly any rain and the sandy soils created dry conditions. A banana plant was planted between four arecanut trees. The suckers of the banana absorbed moisture during the rainy season and released it to the roots of arecanut during the winter season. Obviously, this is a very sustainable practice (Gupta 1987e).*

Participatory research should not merely emphasize the work that women do. Not because the work women do is not important, but because an emphasis on work detracts from the very necessary recognition of the intellectual contribution of women. Many women develop insights during the course of their work; these will become available for building upon only when there is a valorization of the intellectual capacities of women. For instance, the criteria for selecting seeds, practices of animal care, food processing and the consequent preferences for different kinds of blending of various food materials, are useful starting points for building in women's perspectives in research. We have also seen that the articulation of women's knowledge often best takes place within women's own networks. There is no judgment involved in this statement; it just so happens that the way in which society has developed in the past perhaps makes this option optimal, at least for the present. Of course, this cannot be generalized for all cultures.

One should not try to ascribe a value base to women's practices that is entirely different from the one that is ascribed to men. For instance, women money-lenders are known to be as unfair to poor women borrowers as men money-lenders (Gupta, 1983). Similarly, women can be as secretive about their recipes as men are. However, the different experiences of women, and the culturally-specific socialization processes that they undergo, do make for a uniqueness in women's perception of the relationship between nature and day-to-day existence. To that extent, a case for the feminization of the research agenda can be made. This is essential in order to correct the prejudices that have hindered the rate of technological change in many of the activities that women perform. A good example, reported above, is the design of pulley used by millions of women for drawing water from wells. It should be possible to make a ratchet mechanism which reduces the burden that women have to bear while pulling up buckets of water. Unfortunately, we are not aware of any large scale use of improved pulleys. The workshop of artisans, cited above, did suggest some changes, but they need to be followed up. Some of the approaches which appear necessary in a gender-sensitive participatory research agenda include the following:

- Focusing on the problems of the regions, sectors and enterprises in which women have to bear the highest burden;[19][20]
- Identifying differences in the relative weights that men and women attach to the different kinds of consumption of the various family members;[21]
- More involvement of women in the management of certain enterprises, like livestock, food processing, seed processing, may result in the development of unique skills.[22] Many women distinguish between the waters of different wells; for instance, the water of a particular well may be used for cooking pigeon pea, which takes a long time to cook;
- Recognition of the differences in the articulation of preferences, individually or collectively, spontaneously or through iterative interaction;[23]
- Gender aspects need not necessarily only imply contrasts, they may also indicate complementarity.

19 When we reviewed the curriculum of some of the leading women's studies programs in the country, we did not find any reference to women's unique indigenous knowledge in the technological, educational or institutional fields. There is no recognition of the fact that the proportion of women-headed or managed households is much higher in drought-prone regions, hill areas, forest fringe areas and flood-prone regions.

20 In a drought-prone region, it was noted that women grass sellers become more vulnerable when they try to negotiate prices in the evening, because of the compulsion to return to home before it gets too late.

21 Studies have shown that women give greater weight to consumption than men, though they may discriminate in favor of sons over daughters in some cultures. Similarly, they seem to prefer fruit species over timber species, in contrast to the men. Even in terms of allocation of household expenditure, women would tend to use different allocation criteria, constrained of course by culture, socialization and family histories.

22 If most sale and purchase transactions of cattle are done by men and of backyard poultry by women, it is reasonable to assume that knowledge about selection criteria relevant to the different species will also vary. Similarly, the nurturing role of women gets manifested most in livestock care, where the individual idiosyncrasies of different animals are tolerated to a greater extent by women than men. Paradoxically, this is a trait which men may show in no small measure in the case of horses, bullocks and other animals with which they spend more time.

23 This constraint applies to men as well, though it is applied more often to women. This also suggests that rapid methods, which emphasize group interaction more than individual interaction, may generate a false understanding of the general concerns. The difference between espoused theories and theories-in-use is well documented in literature. Studies on participatory research have ignored this aspect.

## Conclusion

We have been arguing for almost a decade now that the very model of technology development and transfer needs to change as far as the problems of high-risk environments are concerned. The essential argument is that, given the high ecological variability in such environments, developing technologies for different niches through the classical models of on-station research is impossible. Budgetary constraints prevent large-scale on-farm research by the public sector scientists. What, then, is the choice?

We have to identify the best solutions, derived locally, to any technological problem, understand their scientific bases, add value to them, and then share the value-added scientific principles with the farmers. The technologies will be developed by the farmers through their own research which may or may not be monitored by scientists. This approach is different from the farmer-back-to-farmer or similar approaches, because the emphasis here is on transferring science, and not technology, to farmers. Also, as argued elsewhere (Gupta 1980), it is not enough to look at just two-way communication between farmers and scientists. One must convert this pattern into a genuine two-way power arrangement in which reciprocities may be ensured. A brief example would illustrate this point. In southern Bangladesh, we observed that paddy farmers increased the number of hills per square metre and also the number of seedlings per hill as the transplanting was postponed due to a delay in the receding of the water. Their aim was to optimize the number of ear-bearing tillers per unit area. Scientists then calculated an equation by which one could work out by how much the number of seedlings and hills per unit area needed to be increased, for a given period of delay. The other contingent conditions that influenced this coefficient were also specified. In other words, an approach which takes the route of farmer innovation-science-farmer innovation is desirable for promoting sustainable development.

The real challenge for sustaining the intellectual participation is to nurture and build a culture of experimentation. SRISTI and the *Honey Bee* network have been trying to meet this challenge through initiatives like the *shodh sankal* (network of seekers or experimenters). Such fora can provide a space for innovators to share their successes and failures. They can also identify and reward innovators. We hope to intensify our efforts in strengthening such networks.

Finally, we would like to state that an excessive reliance on the classical research approach is like driving with the help of only a rear view mirror. We can see the road traveled, but the road ahead will not be visible. The excessive focus on the politically well-organized farmers of irrigated and input-intensive regions has darkened the front view glass. Thus, in addition to recalibrating our route maps, we need to perhaps redesign the vehicle itself.

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# ISSUES OF RESEARCH DESIGN: FREE EXPERIMENTATION VERSUS CONTROLLED EXPERIMENTATION INVOLVING USER PARTICIPATION

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## Introduction

The rhetoric of participation has reached most institutions and individuals dealing with rural development. The perceptions among the actors of what participation is, of who participates in whose projects for what purpose is highly diverse and often contradictory. In agricultural research, participation is often seen as a methodological issue and an issue of research design. Unfruitful arguments among researchers at the level of experimental designs are still common, which indicates that major criteria at metalevel are either not understood or not applied in making decisions about the research design.

In this context, the given topic 'free experimentation versus controlled experimentation using user participation' has to be approached from a conceptual level, departing from the development philosophy. There is no blueprint advice on the design to choose. A number of criteria which all depend on the goals and on the context have to be applied as a basis for decision making. Some stimulating thoughts will be discussed in this paper.

## Some Criteria for Decisions on Research Designs

### *Setting priorities in the research goals*

Several issues deserve consideration when clarifying research goals:

**What are the goals and the anticipated output of the research?** The quality of research outputs could be at three different levels:

- knowledge (e.g. a contribution to the understanding of processes);
- a product (e.g. a new variety); or
- a shared responsibility for an overall practical impact at the target group level (e.g. increased food security, poverty alleviation)

The choice of the output level can depend on funding criteria and on personal interests and objectives of researchers and their institutions. From the definition of the output level, the identification of whose questions should be answered is evident and the indicators for success will further determine the relevant bottom line where research should become active at a technical level. For example, in order to improve animal production in communally-owned lands, the impact of research on the metabolism of small ruminants will most probably yield less direct impact than research geared towards improving the collective management of the grazing lands which might directly improve the feed source.

**How does this affect the choice of the research design?** The clarification of the priorities and the desired goals would allow for the precise definition of the required research results and thus the type of research. The closer the focus is on the practical impacts, the greater user participation (up to free experimentation) might be required.

*Clarification of The Mode of Operation*

When defining the research design, one should clarify whether one works within the 'Transfer of Technology' (TOT) model or whether research should be a part of the users' learning process. Within the TOT model the responsibility of research is limited to providing scientifically valid research results to extension, which would translate these results into messages to be transferred to farmers. The involvement of farmers into the research process then has the function of improving the efficiency of research in the development of appropriate solutions. User participation has a functional and instrumental character (e.g. adaptive trials to verify a certain technique).

The re-thinking of the TOT model is of fundamental importance if research is to take a shared responsibility for an overall impact. The limitations of the TOT model have been emphasized again and again (particularly in marginal areas with a highly diverse and complex environment). The diversity of conditions in such environments casts doubt on the development and spreading of blueprint solutions which can be successful in large-scale farming but make little impact in smallholder farmer conditions. A good example is provided by the contour ridges in Zimbabwe which have been promoted for several decades. In more than 90% of the fields, contour ridges were dug, but the result of a recent survey indicated that 66% of them have actually accelerated erosion rather than stopped it (Hagmann 1996). Therefore, research and extension in NRM, in particular, has shown that successful conservation is more than the adoption of certain techniques, and an impact can therefore only be made by building the users' capacity. The users must be able to understand the biophysical processes and be motivated to monitor their own fields and choose or creatively generate their own appropriate options to solve the identified problems at plot level within the fields. In addition, only collective efforts have shown promising results. Collective efforts can be facilitated through collective and social learning processes which then become an integral part of research and extension (Röling 1996).

**What are the implications of a learning process?** The diversity requires that the users enter a learning process (learning by doing) in which the joint development of technologies yielding appropriate solutions as options and an increased problem-solving capacity in the user is the goal. In this case, the development of human capacity through learning and empowerment is the focus. The research objective is then not to generate ready-made technologies as 'products'. Instead the focus is the development of prototype approaches and technologies, learning about technologies and the understanding and the interaction of factors which contribute to success and failure of technologies. These results can be fed back to farmers as a basis for their decision making and to inspire participatory learning and action.

The interdisciplinarity of this type of research is obvious. There are three central research elements: the technical questions and problems, communication and pedagogic aspects and the sociocultural context. It is evident that sound technical and social competence is central to the joint development of technologies. This will require a new quality of interdisciplinarity, namely, that each researcher will have to internalize both perspectives in order to be able to understand the sociotechnical environment. A new 'professionalism' as stated by Pretty (1995) might be required.

Impact-oriented research will also require institutional changes. Once research takes a shared responsibility at the target group level, research and extension cannot be separated artificially and rigidly any longer through mandates. Research will have to include other actors if the agricultural knowledge and information system and spreading of information among the stakeholders and networking are to become specific research topics.

**How does this affect the choice of the research design?** When choosing the research design, the mode of operation is a crucial determinant. If one works within TOT, controlled experimentation involving user participation contributes to the immediate goal of improving the research efficiency. In most cases, however, an in-depth analysis will show that a learning process approach (e.g. participatory technology development (PTD) or participatory action research (PAR) is required to create an overall impact. If research shares that responsibility, the encouragement of farmer experimentation and free experimentation is a crucial tool to revive and build up farmers' knowledge and confidence. This enables the joint development of innovations in a research process, as the users will come up with their own ideas far more openly than in a researcher-dominated controlled experimentation process where the user is simply a participant.

*Requirements of The Technologies Involved*

An important criteria in the choice of the research design is the technology to be worked on. Research in biotechnology will in most cases allow less space for a user-driven process than, for example, research in NRM. Accordingly, the question of free experimentation or controlled experimentation has to be evaluated with regard to an obvious pay-off of free experimentation or of standardizing experiments.

**Free Versus Controlled Experimentation: 'Either - Or', or Better 'As Well As'?**

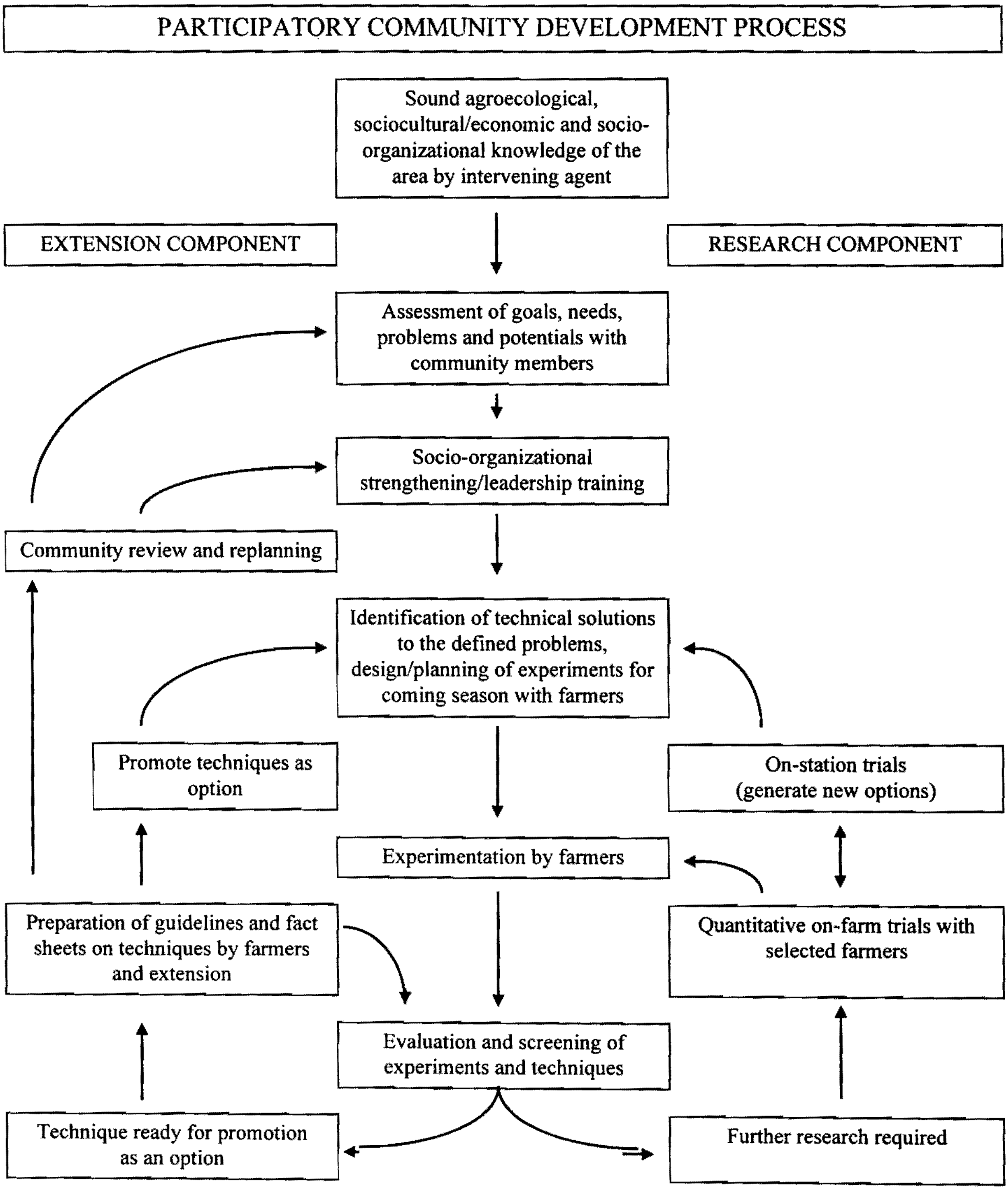
Free experimentation and controlled experimentation do not necessarily have to be exclusive. A combination of both is possible and might increase the total pay-off of the participatory research. The key to research sharing the responsibilities for an overall output is the definition of the research questions and the research agenda. This is a continual process of negotiation among the stakeholders. Research questions have to arise out of the analysis of the users' problems and needs.

Free experimentation by the users with local ideas and solutions can be a starting point, likewise a brainstorming with ideas. The need for further research can be formulated based on farmers' and researchers' evaluation and the promising techniques can be selected, either by the users or jointly and tested in a slightly more controlled environment together with both farmers and researchers. Simple designs can serve the purpose of a learning tool (learning through comparing the performance of crops with the conventional and the new technique). Simultaneously these designs can fulfill the criteria for a reasonable statistical analysis, in which case, both partners have their benefits and can learn about their different evaluation criteria. Farmers' qualitative evaluation as well as researchers' quantitative evaluation can provide valuable information to understand the performance of the techniques. In case of uncertainty about biophysical processes, even controlled on-station research is valuable if it arises out of the research questions being dealt with on-farm. The main point is the feeding back of these results into the experimentation cycle.

To illustrate a concept which integrates a participatory community development process, an extension loop and a research loop is shown in Figure 1. This was developed on the basis of practical experience in the Agritex/GTZ Conservation Tillage Project in Masvingo/Zimbabwe Hagmann *et al*, 1996). Research activities of that nature should be set up for at least 5 years, so that answers to the specific research questions and solutions to the problems occurring during the process can be found. Besides technology development, these research activities should also have the character of approach development out of the learning process. A detailed process documentation and analysis is essential for a synthesis of lessons learnt in a concept which other actors can apply and adapt in other areas. The leading goal and principle in the research process is the achievement of an overall impact at target group level.

**Figure 1: Conceptual model for participatory research & innovation development and extension**

*Kuturaya*
Participatory Research, Innovation Development and Extension: The Concept



## Conclusion

The issue of research design is basically a question of the vision and the research goal. Once these have been set, the question of the research design can be dealt with at a very pragmatic level and the research and experimental design becomes a tool and is not an end in itself. In the case of impact-oriented research, user participation becomes more than an experimental design question.

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# PARTICIPATORY NATURAL RESOURCE MANAGEMENT RESEARCH IN THE DRY AREAS: CHALLENGES AND OPPORTUNITIES

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## Introduction

There is a great concern among researchers, development agencies and policy makers about the degradation of natural resources (soil, water and natural vegetation) and its potential impact on the sustainability of agricultural development in dry areas. Increased food demand, due to a rapidly growing population and rising income levels, requires high rates of resource use which could lead to irreversible degradation. Conflicts arise among alternative land uses (permanent tree crops, grazing, rainfed cropping, urban expansion, etc). As pressure mounts on limited land resources, farmers adopt intensive production systems with little regard for future consequences. Cereal production encroaches into the marginal areas traditionally reserved for extensive grazing. Furthermore, due to the increasing demand for livestock products, livestock numbers continue to increase and the subsequent overgrazing degrades rangelands. Traditional conservation practices and supporting institutions are disappearing, causing accelerated soil erosion and the siltation of dams. Communal grazing systems in the dry areas, traditional mountain terraces in Yemen and *jessours* in Tunisia are examples of this. Other environmental impacts of land degradation include the loss of natural biodiversity which endangers the potential future crop improvement.

Policy makers are becoming increasingly aware of the degradation of natural resources, its implications for rural poverty, and its social and political repercussions. The direct linkage between resource degradation and poverty is becoming more obvious. Poverty in the marginal areas is caused by low productivity, which , in turn, causes farmers to overlook the long-term effects of resource degradation while struggling with their immediate or short-term needs. The rural-urban population migration, which is a result of increasing rural poverty, causes substantial social and environmental costs such as congestion, unemployment, pressure on social services and health risks. To counter these challenges, the efficient use of available natural resources is now an integral part of rural development strategies in many countries. Public land reclamation and development projects are undertaken and private investment in land reclamation and improvement is encouraged, for example, in Syrian, Egypt, Jordan and Tunisia. The objectives of these policies are to increase agricultural productivity, improve farm income and improve the well-being of rural communities and hence help to reduce rural-urban migration.

Although public awareness of the efficient and sustainable use of natural resources is increasing, the adoption of proper resource management practices is inadequate for various reasons. First, natural resource management research falls to the bottom of research priorities in most national research programs. Thus, most national programs have insufficient capacity to conduct interdisciplinary, problem-solving research in resource management. Secondly, local people who are directly affected by resource degradation and who ultimately make management decisions are not fully consulted, which discourages their much-needed co-operation. The wealth of indigenous knowledge locally available is not fully incorporated into the research process; but, without community participation, research and extension systems are unlikely to develop useful solutions for resource-poor farmers who make decisions under complex and risky environments in the dry areas. Thirdly, policies and programs sometimes contradict and send the wrong signals to resource, users which would undermine sustainable resource management.

**Strengthening Participatory Resource Management Research in the WANA Region**

The International Center for Agricultural Research in the Dry Areas (ICARDA), in collaboration with several national agricultural research systems (NARS) in the West Asia and North African (WANA) countries, initiated, in 1990, interdisciplinary and participatory resource management research under the umbrella of the Dryland Resource Management Project (DRMP). The project now covers 6 countries in the region where NARS have organized multidisciplinary research teams to conduct this research. Most teams work on soil and water management problems, but the emphasis depends on local conditions. The common linkage among teams is the interdisciplinary approach and farmer participatory methodologies. Integration of different disciplines allows different specialists (biophysical and socioeconomic) to formulate a holistic approach and assess priorities for the complex problems of land and water management, while the participatory approach ensures that the perspectives and views of individual land users and communities, who will ultimately have to make resource management decisions, are heard and their indigenous knowledge incorporated into the research process. Users' participation enables researchers to appreciate farmers' role and the complementarity between their knowledge and skills and those of researchers. The teams share these methodologies through workshops and field tours.

DRMP was founded on the premise that resources allocated for adaptive resource management research in the NARS of WANA region are inadequate because priority in the use of limited financial resources is always given to productivity enhancement research. Thus, most national research systems lack the necessary capacity to address natural resource management problems. The goal of DRMP was, therefore, to assist national research systems to expand their capacity in adaptive resource management research through multidisciplinary (holistic) and participatory approaches. With seed money provided by ICARDA and by a number of donors including the Ford Foundation, the International Development Research Center (IDRC) and the OPEC fund, in the first phase of the project, teams completed diagnostic case studies and identified issues for further research. In the second phase, work continued for two countries; Yemen and Lebanon, which were able to obtain further external funding. The lack of external funding has limited the continuation of the research in other countries. Nonetheless, ICARDA continues to encourage the national teams in seeking funds, and some counties like Tunisia, Lebanon and Yemen, are experimentimg with new ways of involving farmers in the research process. The Tunisian case is discussed in this paper.

## Challenges of Farmer Participatory Research (FPR) in Adaptive NRM Research

Farmer participation in research has been implemented in the past in different forms and with varying degrees of effectiveness. Farming systems research (FSR) during the 1980s greatly encouraged the inclusion of farmers' perspectives in the research process (Tripp, 1991a). On-farm research, which was an essential component of FSR, enhanced farmer participation in the technology development process (Tripp, 1991b). Biggs (1989) described different forms of farmer participation such as contractual, consultative, collaborative and collegial. In conventional participatory approaches, researchers use group meetings, individual interviews, participatory rural appraisals (PRAs), and formal surveys. Farmers also participate in the management of on-farm trials. While those methodologies increase researchers' understanding of the farming situations and, to a certain extent, include farmers' constraints and preferences in the research process, they do not sufficiently enhance a community's capacity to conduct experiments itself. Although farmers have experimented with different practices since crops were domesticated, and accumulated knowledge has been passed on by the generations, formal experimentation still remains the researchers' initiative.

An alternative approach for farmer participation is presented by Ashby *et al* (1995). This focuses on the ability of research and extension services not to transfer technologies but rather to transfer the knowledge of how to do experiments which could be initiated and managed by communities with the support of professional staff. The approach aims to increase the capacity of local communities to generate technologies by using both indigenous and modern knowledge and skills. It, therefore, involves a new partnership between research and extension professionals and farmers which enables researchers to spread their time over a large area; thus increasing research efficiency. The question is whether such an approach presents a greater opportunity for adaptive natural resource management research?

Although farmers' consultative participation in research is now widely practiced through formal and informal surveys, by PRAs and by discussions with community leaders and farmer groups, the collaborative participation whereby farmers are involved in making decisions on the research agenda, prioritization, design and implementation, has been less frequently used in adaptive NRM research. Partcipation through farmer groups (Heinrich, 1993) and the community-based research through farmers' organizations ( Ashby and Sperling 1996, Ashby *et al.* 1995) may present a greater opportunity for adaptive NRM research, for two main reasons. First, the land and water resource management situations of resource-poor farmers are immensely diverse and the problems complex, so that any recommendation developed under a given situation will be bound by location-specific conditions. Research and extension systems do not have the resources to develop technologies and management systems which are appropriate for each and every situation. This dilemma could be solved by decentralizing research through collaborative participation. Secondly, resource management is often affected by institutional as much as technological factors. The Development of institutional innovations, for example for collective action or conflict resolution, definitely needs greater community involvement. But national research systems face many challenges before participatory approaches can be effectively institutionalized. A few of those challenges are discussed below.

*Cost-effectiveness*

One of the reasons why research systems are slow in adopting FPR methodologies, in general, and collaborative (or decision-making) participatory approaches, in particular, may be due to the belief that participatory research is very costly (Farington and Martin, 1988). However, Ashby *et al.* (1995) reported that researchers' time requirement has been significantly reduced when community experimentation was used instead of conventional on-farm trials. The cost-effectiveness of participatory research is important for research managers and donors. Impact assessment is increasingly becoming a requirement in research projects. Effective participatory methodologies in adaptive NRM research require innovative ways to forge new partnerships between farmer organizations/groups, research and extension services, non-governmental organizations (NGOs), development agencies and international agricultural research systems. Those new partnerships involve ways of sharing costs and responsibilities among stakeholders. The cost of research, however, has greater implications for NRM research for which results may not be obtained for several years, and, in some cases, long-term monitoring may be necessary. The unanswered question is: how much enthusiasm will farmers have in initiating such research without any short-term benefits in sight?

*Researchers' Attitudes*

Researchers' attitudes toward farmers are fundamental in any successful participatory research. Researchers in many national research systems are hesitant or unwilling to appreciate farmers as researchers in their own right and to respect their acquired knowledge. Farmers have, over the years, accumulated wisdom and knowledge about their environment which could contribute to potential solutions. Researcher training through practical experience (learning-by-doing) and networking with other researchers can help change attitudes and improve farmer-researcher relationships.

*Interdisciplinary Team Work*

Adaptive research on soil and water management needs the co-operation of different disciplines. Interdisciplinary team work is not easy. Most researchers, trained in specific disciplines, seek single component solutions or fixed package solutions to problems according to their own perspectives. Flexibility in research approaches is needed to accomodate different situations. Few researchers are trained or experienced enough to present options to resource-poor farmers making difficult resource management decisions, or to encourage farmers to identify their own problems and participate in the design of trials. Nor do researchers necessarily have the organizational and managerial skills required for effectively involving farmers in research. Social scientists, who are trained in these skills, are often scarce.

*Local Institutions*

In the absence of external effects, participation normally involves one user when a resource is owned by an individual (private property). However, in many situations, resources are managed by communities (common property) or by the state (public property), or resources are open to all users (open access), or the effects of management practices of individuals or groups of users spill over to other users (external impact). Participation is much wider in these situations, involving an array of decision makers and local institutions. Nonetheless, different individuals and groups within any community may often have conflicting interests, depending upon access to resources, gender and ethnicity (Farrington and Martin, 1988). Local institutions and mechanisms by which formerly those conflicts were resolved and collaboration ensured are changing, due to the changing socioeconomic environment, with consequences for resource management. The challenge is to understand the dynamics of these changes and foresee the future shape of these institutions and, therefore, anticipate how that will affect the participatory approach to be used.

*Institutional Commitment*

As mentioned earlier, productivity enhancement has dominated the research agenda of most national research systems, and a relatively lower priority has been given to NRM research. Adoption of participatory approaches to NRM research has also been lagging behind that in commodity research, following NARS research priorities and commitments and the donors' funding structure. Greater institutional commitment from NARS and funding from donors is needed if participatory methodologies are to be effectively employed in adaptive NRM research. This includes allocation of resources, training of researchers and proper promotion and incentive structures in the research system.

## Participatory NRM Research in South Tunisia

*Problem Diagnosis*

Southern Tunisia is dry with a long-term average rainfall of around 200 mm. The landscape consists of undulating hills and mountains denuded of natural vegetation. Soils are poor and extremely shallow and rocky. The *jessours*, based on the principle of water harvesting, are ancient indigenous systems. They consist of a series of stone and earth walls, called *tabias*, built across the stream beds of narrow valley watersheds. The *tabias* collect and retain soil washed down hillsides by the torrential rains, forming terraces arranged in stair-step fashion down the natural slope. The rainfall runoff collected on these terraces permits the cultivation of olive and barley (traditional crops), as well as chickpea, faba bean, lentils, watermelons and vegetables. More recently, due to increased demand, new fruit trees like figs, grapes and apple have been introduced into the system in the relatively higher rainfall Matmata mountains. This intensification of the *jessour* production systems makes the efficient use of available rainfall water even more important. It also raises the stakes of any damage to the system.

While poverty is more prevalent in rural areas of Tunisia than in urban areas (Ayadi and Matoussi 1995), the situation in Southern Tunisia is exacerbated by low natural resource endowments. Agriculture, which is the main economic activity, faces low and erratic rainfall, increasing pressure on marginal rangelands by overgrazing, and accelerated soil erosion ( IRA 1993). Many of the traditional *jessour* systems are not being well maintained, resulting in increased run-off during torrential rain storms which destroy those systems with substantial environmental and economic costs. Although water is a major factor limiting agricultural development, available water from rainfall is not efficiently utilized because of the run-off losses. This run-off, in turn, accelerates soil erosion, further deteriorating the agricultural resource base, reducing its productivity and threatening its long-term sustainability.

Furthermore, as agricultural land is degraded and productivity drops, communities seek other ways to support their livelihood, and this region has been affected by a mass out-migration. As a result, labor shortage has increased the cost of production and of land conservation practices. However, even though many farmers have neglected their fields, there are signs of increasing land stewardship among some farmers, reflecting increased land values following the introduction of new crops and production intensification.

*Development of Potential Solutions*

Tunisian researchers at the Institut des Regions Arides (IRA), located in Medenine in South Tunisia, have been developing techniques to optimize the use of water resources and minimize soil loss due to water erosion in the *jessour* production systems. Researchers at IRA have concluded from earlier studies that traditional and conventional techniques used to manage run-off water and reduce soil erosion can be improved to withtstand the intense rain storms that occur in Southern Tunisia (Chehbani 1990 and 1996). Researchers have developed water retention and erosion control measures, using a computer-based watershed run-off model. These measures include additional terraces and planting medicinal and forage plant species on the degraded hilltop to capture surface run-off and reduce soil erosion. Other techniques include flood-water discharge systems, subsurface stone-filled pockets for irrigating fruit trees with increased water-use efficiency and reduced evaporation losses, and the construction of cisterns to capture run-off water for the supplementary irrigation of fruit trees and crops. Some of these measures were tested at experimental sites, but without any farmer participation. The measures were, nonetheless, found to be technically feasible and more effective than traditional and conventional techniques currently used by farmers and by the soil and water conservation service (SWCS), in capturing run-off water, minimizing soil loss and reducing the likelihood of major damage to the system from very intensive rainstorms.

*Involving Farmers*

**Farmers' concerns voiced.** An interdisciplinary team of IRA researchers have conducted a comprehensive socioeconomic study during the first phase of DRMP. This study and subsequent rapid participatory diagnosis using individual interviews, group meetings and brainstorming sessions with farmers conducted by ICARDA and IRA researchers, in the second phase of the project, has revealed that researchers, farmers and SWCS staff have diverse views and perceptions of the problems, their solutions and the socioeconomic viability of the researcher-suggested techniques. First, farmers considered those techniques very expensive and impractical because they were designed to protect the *jessour* systems from the damage of rain storms with intensity up to 200 mm/hour, which is more than the recorded maximum in the study area (110 mm/hour). Secondly, farmers reported that they generally expect to experience a major storm every 15 to 20 years and expect then to repair any damage to the system. So farmers rationally determine their investment levels and accept a certain degree of risk. Thirdly, there is a great interdependence of individual fields in the cascade of *tabias* in any *jessour* system. Farmers use the unproductive upland simply as catchment and the runoff is diverted, through elaborate traditional canals known as *Hamala,* to the productive lowlands. Those farmers consider this runoff vital to their production. Lowland users rely on the runoff which spills over from their upstream neighbors through specially designed spillways known as *masraf* constructed on the *tabias* for that purpose. But lowland farmers do not have the right to claim compensation from upstream users for losses from reduced spillover or damage from increased floods. Any improved technique should, therefore, take these local arrangements and system interdependence into account. Because of the system interdependence, collective willingness to co-operate in overall system improvement is crucial. In addition, there are unanswered questions about the property rights and local arrangements for access to different resources. For example, do all farmers have access to the water collection area on the hillside and the run-off delivery systems (*hamala*) , and how would that affect the viability of improved practices? And, finally, the improved soil and water conservation techniques have not yet been subjected to any *ex ante* economic evaluation by users and social scientists.

**Farmers' participation changes research plan.** Farmers' main concerns were the cost of investment, because farmers have no access to financial resources, and the risk inherent in the recurrent droughts in the region. Other concerns included lack of finance (government not responding to their requests), labor shortage (most young people migrate to urban centers and abroad), diseases of new crops, poor land leveling, poor run-off water distribution and occasional destruction of *tabias* during torrential rains. To meet these concerns, researchers proposed adjustments to the research plan. The experimental designs generated by the computer model will not be introduced as a whole to farmers' fields. Instead, farmers will be exposed to the techniques in a field tour for evaluation, and will then freely select what they think will fit their situations. Farmers' preferences were key elements in determining which techniques will be tested on farmers' fields. Only simple techniques will be selected for testing. The computer model designs will be subjected to ex-ante economic analysis using different rainfall intensity levels and distributions. Detailed cost benefit analysis of the suggested improvements will be carried out, and due consideration will be given to traditional mechanisms and interdependencies of the system.

**Farmers' selection of techniques.** A group of farmers were invited for a field tour to visit the pilot site where the techniques were being tested. After the visit and discussions with researchers, four farmers were selected to test a few techniques on their fields. These experiments are currently underway. The techniques tested in collaboration with farmers include: a water cistern which stores run-off water for supplemental irrigation with an easy-to-use control tap at the bottom; a subsurface stone pocket for the irrigation of fruit trees and other subsurface irrigation techniques using plastic tubes; and a floating system designed to evacuate excess run-off water collected behind the *tabias* in the *jessour* systems to avoid breaking. Participating farmers are enthusiastic about the enhanced water availability and plan to introduce new crops that the researchers did not anticipate.

## Conclusion

Although the work in South Tunisia is only at an initial stage, it shows how farmers' involvement has changed research design and demanded flexibility on the part of researchers in implementing a collaborative participatory approach in NRM research. However, it is obvious that individual farmer participation will not solve the problem where collective action is necessary. The research team has currently adopted a watershed perspective, where groups of farmers using several *jessour* systems in a microwatershed are identified and their collective action is utilized. The comparison will then be between two *jessour* systems (improved against control) rather than between two fields. Researchers also plan to examine the significance and contribution of the participatory methods to the technology development and adoption process. The research will also assess the potential of this approach for scaling up the use of improved soil and water management technologies in this region.

The Tunisian case study did not use a participatory approach blueprint. It was a learning process, in which interaction between researchers and farmers shaped the research design. With greater institutional commitment, adequate funding and proper researcher training in participatory methods, this process could be accelerated, yielding benefits to poor farmers and enhancing resource and environmental conservation.

The Soil and Water Conservation of the Ministry of Agriculture is involved in this work with IRA, partially covering the cost of the experiments. Because of this, the two agencies are now seeking ways of formalizing their co-operation in involving farmers in the adaptive testing of technologies, to serve the interests of both. The Tunisian case study was used as the venue for a field workshop attended by researchers from 6 countries in the WANA region. The case study generated stimulating debate among participants and between researchers and local Tunisian farmers.

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# DEVELOPING SOIL AND WATER MANAGEMENT TECHNOLOGIES FOR SMALL-SCALE FARMERS IN THE SEMI-ARID AREAS: METHODOLOGICAL CONCERNS FOR PARTICIPATORY RESEARCH

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## Introduction

In many countries, the semiarid areas constitute a significant percentage of the total area, and a considerable number of people live and farm in these areas. For example, in Zimbabwe, 83% of the country lies in the semiarid natural agroecological Regions III, IV and V. These regions are characterized by unreliable rainfall with an annual average of about 600 mm. Drought-induced crop failures occur in one out of every four years. Although the mean annual rainfall is low, the intensity is very high and exceeds infiltration, resulting in high water losses due to surface runoff, estimated in Zimbabwe to be up to 30% of total rainfall. Also, the high-intensity early rains normally fall when the ground is totally bare, thus resulting in high soil losses. Annual losses of up to 50 - 100 tons/ha have been estimated. The soils are sandy and inherently infertile. The resource-poor farmer who operates under these conditions is highly resource constrained. Arable land holdings are of subeconomic size and the farmer can hardly risk investing resources in technologies developed under research station conditions which are not guaranteed to work under his conditions. Soil and water management technologies should aim to address all these constraints of the small-scale farmer in the semiarid areas. Soil management technologies include soil erosion control methods, water harvesting techniques and physical and chemical soil improvement practices. This paper raises three major issues that are pertinent in research-driven farmer participatory research for technology development in the semi-arid areas. The questions raised are based on the authors' experiences in the research and development of soil and water conservation technologies in Zimbabwe.

## Key Methodological Issues and Questions

The following issues are crucial in the development of soil technologies:

*Benefits of soil management technologies are long term and depend on other agronomic activities (farmer management skills)*

The impact of soil management technologies, particularly soil erosion control techniques, tend to be long term. This was confirmed in an experiment to evaluate four conservation tillage systems in southern Zimbabwe. The conservation impact of the best system only became apparent in the sixth year (Chuma & Hagmann 1995). Thus, in the first five years, the benefits of conservation tillage were not apparent. Also, the benefits of soil management technologies, particularly in terms of crop performance, are masked by other agronomic activities and the impact tends to be farmer and site specific. This can also be illustrated by the results of on-farm evaluation of a conservation system in Zimbabwe. Yields on farmers fields were highly variable between farmers and seasons. In 1992/93, grain yield on sandy sites was 6% higher on ridges than on conventional flat. In the same year, grain yield on periodically water-logged sites was 22% more on the new technique (tied ridging). In 1993/94, tied ridges on waterlogged sites yielded 66% more than the conventional technique and, on upland soils, ridges yielded only 16% more than on the conventional technique.

Methodologically, the question here is how to separate the impacts of soil management technologies from the effect of other agronomic practices and farmers' management skills? Researchers are looking for quantitative results, while the high degree of variability of yields of the same technology from farmer to farmer is a reality. Highly sophisticated research designs, however, would compromise farmer participation. Another important question is how to reconcile long-term objectives of soil management with the short-term requirements of crop production.

A possible solution is to apply a land husbandry approach which implies the care, management and improvement of land resources as a positive approach, and where soil management technologies are applied as an integral component of land management this, however, requires addressing several problems/issues at the same. The question here is whether it is possible to address all the important issues from different disciplines simultaneously, for example, when applying research funds? Maybe prioritizing the issues could help in the initiation of a land husbandry approach, but again the question is, how to get the right priority for farmers and the soil.

### *Dynamism of the Social Environment and Production Constraints*

Farmer circumstances tend to be dynamic which makes the understanding of farmers' social environment rather difficult. The importance of understanding farmers' circumstances and their decision-making criteria is crucial in technology development on how to extract the impacts of soil management technologies from the effects of other agronomic practices. A combination of evaluation methods that includes formal surveys, informal discussions and technical measurements has been recommended to help researchers understand farmers' social environment, particularly the decision making process (Chuma 1994). Our work in Zimbabwe has shown the importance of incorporating gender as an integral part in the technology development process (Hagmann *et al* 1996), however, it also clearly revealed that the social environment is highly dynamic. For example, household headship can change from male de facto to de jure in a year. Considering the long-term nature of experiments on the development of soil technologies, an experiment started under the circumstances of a male-headed household ends up under different conditions and might have to be changed.

Related to this issue is the dynamic nature of production constraints particularly in the semiarid areas. For example, in a drought year, water harvesting techniques are a key to soil management, whereas, in a wet year, water harvesting becomes totally irrelevant and waterlogging becomes a problem. The challenge for the development of soil technologies here is to build in flexibility during implementation while maintaining scientific quantitative results. The development and application of the appropriate monitoring of diversity is a key challenge in participatory research.

*How To Deal with Diversity of Soil Management Problems?*

Problems to be addressed with soil management technologies tend to be diverse and the objectives depend on the scale of operation. For an individual farmer, the objective to achieve appropriate land management is at the field level, and for a community the scale is at the catchment level. The objectives of the individual and those of the community are not necessarily always equal, but the effectiveness of individual efforts in conservation can only be successful if farmers in a community or watershed are co-operating. Now, whose objective (community or individual) should be addressed by farmer participatory research? Who is putting up the research agenda? Who is the driving force? Who owns the research? Also, the criteria for the evaluation of technologies differ depending on degree of market orientation, gender, wealth, etc. Whose criteria are to be used for evaluation? Farmers' perceptions of problems is highly diverse. For example, some farmers attribute low soil fertility to spiritual effects, while others believe in casual-rational terms, etc. The overall question is how to take these issues on board in participatory research.

## Conclusion

This paper only shows a limited number of methodological concerns in farmer participatory research on soil technologies. These concerns apply when utilizing a research approach based on positivistic science, which is often the case in classical farmer participatory research. However, if take farmers' reality as a starting point in technology development, and do not seek for quantitative data but more for a learning process, the methodological concerns are different. In our work in Zimbabwe, we tried to combine a learning process and simple quantitative research. The methodology and the results have been documented (see references).

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## PROGRAM

## INTERNATIONAL SEMINAR ON "PARTICIPATORY RESEARCH AND GENDER ANALYSIS FOR TECHNOLOGY DEVELOPMENT" CIMMYT, IRRI, CIAT

## CIAT, CALI - COLOMBIA, SEPTEMBER 9 - 14, 1996

***Monday, September 9***

| | |
|---|---|
| 07:30 | Registration and coffee. Meeting of discussion group facilitators |
| 08:00 - 08:10 | Welcome, Jacqueline A. Ashby, Acting Director General, CIAT |
| 08:10 - 09:00 | Objectives and organisation of the meeting, J. A. Ashby and L. Sperling |
| **Session I** | **What is the demand for participatory research and gender analysis?** |
| | **Chair:** **J. Witcombe**<br>**Rapporteur:** **T. Paris** |
| 09:00 - 09:15 | Issue: "What do we mean by participatory research?<br>J. A. Ashby |
| 09:15 - 10:15 | Discussion groups |
| 10:15 - 10:45 | Coffee<br>Sign up for Monday's discussion groups on results of different stages of research |
| 10:45 - 11:15 | Plenary discussion |
| 11:15 - 11:30 | Methodology development issues from a donor perspective<br>R. Vernooy |

| | |
|---|---|
| 11:30 - 11:45 | Methodology development issues from a research management perspective.<br>R. Zeigler |
| 11:45 - 12:00 | Methodology Development Issues from an NGO Perspective<br>Edith Fernández-Baca |
| 12:00 - 12:15 | Methodology development issues from a National Research Program Perspective.<br>N.R. Gata |
| 12:15 - 13:00 | Discussion groups on results of different stages of research |
| 13:00 - 14:00 | Lunch |
| 14:00 - 15:00 | Discussion groups continue |
| 15:00 - 15:30 | Refreshments<br>Sign up for Tuesday's working groups |
| 15:30 - 17:00 | Plenary |
| **Session II** | **What are common and unique methodology development issues in plant breeding and natural resource management research?** |
| **Chair:** | **B.R. Sthapit**<br>**Raporteur: D. Neubert** |
| 17:00 - 17:15 | Methodology development for involving users in natural resource management research.<br>L. Harrington |
| 17:15 - 17:30 | Participatory plant breeding methodology development issues: An overview.<br>S. Ceccarelli |
| 17:30 - 18:00 | Plenary |
| 18:30 | Cocktail followed by dinner |

*Tuesday, September 10*

| | |
|---|---|
| **Session II** | **What are common and unique methodology development issues in plant breeding and natural resource management research? (Cont.)** |
| 07:30 - 08:30 | Discussion groups and plenary |
| **Session III** | **What are the methodology development issues related to building more effective user involment in R & D?** |
| | **Chair:** **M. E. Fernández**<br>**Raporteur:** **M. Willcox** |
| 08:30 - 08:45 | Who participates in participatory research ? Issues in differentiating users of technology.<br>H. Feldstein |
| 08:45 - 09:00 | Methodology issues in strengthening farmers' research and technology development.<br>W. de Boef |
| 09:00 - 09:15 | Methodological challenges for institutionalizing participatory research.<br>L. Sperling and J. Ashby |
| 09:15 - 10:30 | Discussion groups |
| 10:30 - 11:00 | Coffee |
| 11:00 - 13:00 | Plenary discussion |
| 13:00 - 14:00 | Lunch in the recreation area |
| **Session IV** | **Issues of impact and scale** |
| | **Chair** **L. Sperling**<br>**Raporteur:** **E. Chuma** |

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|---|---|
| 14:00 - 14:15 | Assessing the impact of participatory research,<br>D. Pachico |
| 14:15 - 14:30 | Scaling up participatory research,<br>D. Carney |
| 14:30 - 15:30 | Case study exercise |
| 15:30 - 16:00 | Refreshments |
| 16:00 - 17:30 | Plenary presentations |
| 19:00 | Dinner |
| 20:00 - 21:00 | Poster session in the Conference Area |

***Wednesday, September 11***

| | |
|---|---|
| **Session V** | **A general framework for addressing key issues of methodology development** |
| 07:30 - 09:00 | Small group analyses |
| 09:00 - 10:00 | Plenary |
| 10:00 - 10:30 | Coffee |
| 10:30 - 13:00 | **Parallel Sessions: Needed research, and strategies to achieve it** |

**(1) Participatory Plant Breeding (PPB) Working group**

**Chair:** **E. Weltzein**
**Rapporteur:** **C. Iglesias**

Methodology issues for PPB

| | |
|---|---|
| - In open - pollinated crops | E. Weltzein |
| - In vegetatively propagated crops | C. Iglesias |
| - Decentralised breeding | J. Witcombe |

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- In seed systems — B.R. Sthapit
- In farmer breeding — C. S. Basilio
- Participatory research and biotechnology — A.M. Thro

Discussion

**(2) Natural Resource Management working group**

**Chair:** **D. Pachico**
**Rapporteur** **J. Hagmann**

Methodology development issues for NRM Research:

- Issues of collective action in applying participatory methods to technology design in natural resource management research.
  H. Ravnborg

- Participatory methods and systems research.
  M. Loevinsohn

- Sustainability from a community perspective.
  K. Patel, A. Gupta

- Discussion

- Issues of research design: free experimentation vs controlled experimentation involving user participation.
  J. Hagman

- Special issues for developing soil management technology: insights from Tunisia.
- M. Sghaier & A. Aw-Hassan

- Special issues for developing soil management technology: insights from Zimbabwe.
  E. Chuma

Discussion

13:00 - 14:00 Lunch

| | |
|---|---|
| 14:00 - 15:30 | Parallel sessions (cont.)<br>Discussion of needed research, priority themes and possible research designs<br><br>(Refreshments) |

**Session VI** **Synthesis**

**Chair:** **J. A. Ashby**
**Rapporteur:** **L. Sperling**

| | |
|---|---|
| 15:30 - 17:00 | Rapporteurs' reports from the parallel sessions on themes and plenary discussion |
| 17:00 - 17:30 | Overview and summing up of the first three days |
| 19:00 | Evening activity |

**Program Day 4**

***Thursday September 12***

| | | |
|---|---|---|
| 10:00 - 13:00 | | Plenary<br>**PPB and NRM work groups continue** |
| 13:00 - 14:00 | | Lunch |
| 14:00 | 1. | Synthesis of outputs from days 1, 2 + 3 |
| | 2. | Progress report to plenary from PPB and NRM rapporteurs |
| | 3. | Report by Gender works groups |
| | 4. | Discussion in plenary |

5. Organisation of task forces

6. Task forces begin work

20:00 Poster session, videos - Calima and Tairona rooms

Proposed task forces are:

- Impact assessment
- Procedures for partnerships

**Program Day 5**

***Friday September 13***

08:00 - 13:00

7. Plenary progress report of woks groups and task forces

8. Program evaluation
   Plenary presentations

9. Special groups on organisation

10. Special groups go to work

**<u>Proposed special groups on organisation:</u>**

1. Criteria for inclusion of projects in SWI
2. Steering Committees - PPB, NRM, Gender criteria for membership, TOR
3. Training needs
4. Communication network, networking, seminars, e-mail (ie. how are we going to keep in touch?)
5. Others if proposed

20:00 Poster session – videos

## Program Day 6

***Saturday September 14***

| | | |
|---|---|---|
| 10:00 - 13:00 | | |
| | 11. | Reports to plenary of task forces and special groups on organisation |
| 13:00 - 14:30 | | Lunch |
| 14:30 - 16:00 | | Continuation of reports |
| | 12. | Next steps |
| 18:30 | | Musical Recital |
| | | Dinner |