Participatory Research: Does it Work? Evidence from Participatory Plant Breeding

Jacqueline A Ashby[12] and Nina Lilja[13]

[1]International Center for Tropical Agriculture (CIAT), Colombia j.ashby@cgiar.org
[2]The Rural Innovation Institute
[3]CGIAR Systemwide Program on Participatory Research and Gender Analysis

Abstract
Participatory research approaches that involve clients in the process of enquiry are widely practised today in many different branches of agriculture ranging from integrated pest management to applied biotechnology. This paper focuses on participatory plant breeding to show how participatory research increases benefits and is more effective at reaching women and the poor. Used in plant breeding, PR is seen to improve research efficiency and leads to more acceptable varieties thus accelerating adoption. This is probably the most compelling incentive for researchers to use this approach. Although often charaterized as expensive, PR also leads to changes in costs that do not lower breeding program cost benefit ratios and may improve these. The paper shows that a careful choice of research goals, targeting of environments and selection of user communities is required in order for PR to have an impact. Also a systematic understanding of different types of participation is needed to select appropriate PR techniques and tools. The paper concludes that PR or client-driven research when used appropriately and expertly, is a proven complement to conventional non-participatory research approaches.

Media summary
Participatory research where scientists work with farmers can lead to better outcomes from research

Keywords
Decision making, selection, farmers

Introduction
Why would an international congress of crop scientists meeting in September 2004 to exchange ideas about important achievements and new directions in their field, consider the question of whether participatory action research "works" to be one of significance? That this question is even raised is a testimony to the growing recognition of participatory research as a methodology with applications beyond the applied behavioral sciences where it has been an accepted approach for at least half a century. It is important to analyse the reasons for asking this question in a crop science forum because these help both to explain what crop scientists mean by the phrase "Does participatory research work?" and to understand criteria for judging what works, or does not.

Basically, participatory research refers to approaches that involve clients who are usually not trained researchers, in actively undertaking and making decisions about how to conduct research and use its results, together with scientists . One reason for agricultural scientists' interest in participatory research approaches is political pressure from stakeholders who fund their research to respond to demand from client groups, in particular farmers and consumers, for greater relevance. Another reason is to achieve more appropriate technology design and faster adoption by ensuring that research builds on farmers' knowledge of local environmental constraints, plant genetic resources, their own capabilities and their consumer preferences.

In democratic societies with industrialized agriculture, where farmers and consumers may have substantial political influence, the market and the political arena are the main source of feedback from client interest groups about the relevance of research. Nonetheless, even in this setting, research can reap benefits and improve its credibility from client participation in setting research objectives, in the evaluation of research procedures and in the interpretation of results. The influence of consumer scepticism about GM technologies on agricultural policy and research funding in Europe demonstrates this. Even in industrialized agriculture, farmers' local knowledge has on occasions proved a vital resource for agricultural innovation.

When agricultural research is required by its international donors to serve poor farmers and consumers in developing countries, then it is more difficult to discern demand for research. The need for client participation in research is heightened by weak market signals and limited channels of communication between researchers and farmers. Farmers' knowledge of local soils, plants, insects and micro-climates is increasingly valued as a resource for tropical agriculture. Participatory approaches are being used to develop technological innovations blending local and exogenous scientific knowledge.

Today, a growing investment in applying participatory approaches to international crop improvement research reflects more than agricultural scientists'need for better feedback from poor farmers. The disbandment of supply-driven public sector science bureaucracies in developing countries makes the capacity of farmers to take on some of the costs of managing local, adaptive research and innovation increasingly necessary if their farming is to become competitive. Reducing the provision of public sector science has created a vacuum in many countries which is being filled by supply-driven, non-governmental organizations with little formal accountability to poor farmers. Governments, agroindustry and farmers in developing countries are all struggling to find a way to link research and extension effectively to markets so that these form an integral part of a coherent innovation system that can develop and sustain their competitive edge, and as well, enable farmers to find markets as suppliers of environmental services. Fairtrade marketing, now in its tenth year, can require suppliers to demonstrate that producers actively participate in decisions about farming technologies and practices. Thus participatory research is being applied to accelerate rural innovation in ways that now go far beyond the function of providing feedback about farmers' preferences to public sector research.

As public sector funding for agricultural research shrinks, the nature of agricultural science is necessarily changing.[1] The normal science once supported by publicly-funded science bureaucracies is adapting to new priorities and financing mechanisms. Decisions that were once the exclusive privilege of scientists are now open to public debate – for example, the safety of GM tomatoes or the relative importance of corn yields versus monarch butterflies. There is greater public awareness of how technology design drives the distribution of benefits from research and better public understanding of how technology choice embodies tradeoffs among farmers' incomes, researchers' careers and consumer safety. In this changing environment, the question of whether participatory action research " works" and the criteria for answering it acquire new dimensions. When we ask " Does participatory action research work" this questions whether participatory research approaches improve farmers' capacity to innovate and to engage in educated decision-making about what kind of agricultural science and what kind of farming they and their societies require.

The objective of this paper is to contribute to better decision-making about the use of participatory research approaches and methods by analysing what difference they make based on evidence from over twenty years of experience with their application to plant breeding in crop improvement programs. The work using these apporaches is now substantial: we have documented over 200 projects and programs in more than 15 countries, documented in a variety of sources including development project reports, monographs, book chapters and refereed journal articles. In 2000 the CGIAR system reported US $27 million devoted to projects which included participatory research methods. Of these, 144 projects were specifically on participatory research with a combined budget of $65 million (PRGA 2004). There is an ongoing effort to synthesise this experience to enable us to say definitely what approaches, methods and practices "work" and which do not (PRGA, 2002). An important complement to the analysis of experience by practicioners is formal impact assessment. Efforts to increase the number of rigorous impact studies have been underway for several years, but the results have not yet been unified or distilled through a comprehensive meta-analysis. This paper is a first step in adressing that task.

[1].Historically, public sector research in many developing countries, especially in Africa, was established on an institutional model designed to apply science to problems of agricultural productivity, first on export crops during colonial-era, and later, on producing more food. Now, there is widespread movement to reorganize research and development arrangements to be more client responsive, consensual in priority setting, planning and implementation, market and entrepreneurial integrated, and driven by a poverty-reducing agenda. This new paradigm for agricultural research and development recognizes that agricultural innovations come from multiple sources: research staff, development agencies, women and men farmers, NGOs, private companies and entrepreneurs. It focuses on the process of innovation as an organizing principle. The concept of innovation, used in its broadest sense, describes activities and processes associated with generation, adaptation, and use of new technical, institutional, organizational or managerial knowledge. It recognizes the importance of both technology producers and consumers and that their roles are both context- and gender specific and dynamic.

The paper starts with a short overview and definitions of participatory action research because it is necessary to distinguish among the huge variety of approaches being practised and understand differences among these that are significant for our purpose of addressing the question of “what works?” The second section lays out the implications of different modes of participation in research for the types of impact that can be achieved, and then the following section examines several examples which illustrate these different types of impact. Finally, implications of the main findings are drawn.

What is Participatory Research and How is it Practised in Participatory Plant Breeding ?

Before we can begin to addess the question of “what works” in participatory research, even within a relatively narrow sphere such as plant breeding, it is essential to make some important distinctions among the plethora of participatory approaches in use. Since this paper focuses on application of participatory research in plant breeding, we also need to define participatory plant breeding (PPB). PPB has evolved mainly to address the difficulties of poor farmers in developing countries. In fact there is no reason why the approach should be confined to work with low income farmers. Basically, PPB is a set of approaches that apply in situations where client demand for different varietal traits is poorly understood and difficult to diagnose with conventional market research methods. For example, where the variablity of the agro-ecological envirioment requires wide range of different genotypes, or producers are unable to obtain the complementary fertilizer and crop protection inputs needed for many new varieties. Breaking the need for complementary inputs allows the technology to be truly scale neutral and obtainable by women and the poorest of agricultural producers This is usually the case in traditional semi-subsistence agriculture, but the same situation may also apply in emerging markets, such as the ones for organic produce or specialised, boutique varieties. PPB may also apply when producers and other stakeholders in a value chain or even society at large, want to exert a high degree of control over decisions about the use of plant genetic resources and the kinds of plants that are introduced into the food system. For the purposes of this paper, the term plant breeding is used to include the entire process of setting breeding objectives, developing finished varieties and their release up to and including the supply of basic seed to growers. Some PPB specialists like to diferentiate between PPB and participatory evaluation of finished varieties (PVS), but here PPB is understood to include PVS much in the same way that trials of finished varieties are generally understood to form only one part of a breeding program.

To differentiate among the many usages of the term “participatory research” it is useful first to appreciate a fundamental distinction between what are commonly known as functional and empowering approaches to participation.Functional participation in research addresses the objective of improving the efficiency of research processes by involving prospective users of the results. In plant breeding these end users are typically the subsistence and comercial farmers, middlemen, traders, industries and consumers. Functional approaches tend to leave the balance of power in decision-making in the research essentially unchanged – ie. researchers (and their employers) make most of the critically important decisions. Empowering participation changes the balance of power in decision-making in the research process, usually in favor of giving non-research interest groups a more important role in key decisions about the end product as well as in how the research is carried out (Okali et al, 1994; Mikkelson, 1995; Ashby 1996). In practice, functional and empowering approaches to PPB are at different ends of a continuum and there exists an immense diversity of approaches which combine different degrees of user or reseacher empowerment at different stages in the plant breeding process.[2]

In PPB a distinction is commonly made between participatory research in formal plant breeding programs and in farmer-led programs. The latter have a variety of objectives, including conservation, introduction of new crops, promoting independence of farmers from formal breeding programs, disaster-relief, skills development(McGuire et al, 2003). Often farmer-led programs are seen as empowering for farmers by definition. In practice these approaches can employ as varied or narrow a mix of types of empowering and functional approaches to particpation as formal breeding programs.

[2] It is also useful to note that an unrealistic ideal of participatory research may be seen as unobtainable, and may discourage researchers from identifying their projects as engaged in “participatory research.” Similarly, projects may identify themselves as engaged in participatory research when they in fact are only involved in contractual relationship with the farmers. The ways in which participatory and on-station activities are ordered and coordinated differ considerably between different projects, means that it is projects or programs, and not research activities in isolation, that should be evaluated for their “degree of participation”. In other words, a project that does on-farm testing as one of its activity can be still characterized as “participatory research project” if other participatory research activities are also included in the project.

A second important distinction is between participatory research and participatory learning. Participatory research in agriculture is conducted to investigate questions for which neither scientists nor producers have an agreed explanation. Like all research, it involves risk and uncertainty about the outcomes of experimental treatments and it combines use of the scientific method with native emprісism. The result is new knowledge, usually a blend of scientific and indigenous. In contrast, participatory learning is an approach that uses principles of discovery learning to promote knowledge sharing. Adult education in particular uses discovery learning because adults learn better when they uncover concepts and facts themselves than when they are told about them. Note that participatory learning is by definition, empowering. Especially in agriculture, discovery learning involves farmers in running trials and experiments. Probably the key difference between participatory learning and participatory research is that the participatory learning facilitator usually knows ahead of time what the participatory learning experiments will uncover and indeed, has designed the experiments to demonstrate a known practice or principle.

Because participatory learning for agriculture uses experiments, it is also sometimes referred to in the literature and in practice, as participatory research. In PPB, participatory learning typically involves varietal trials which enable the farmers to take part in validating the performance of varieties that have already been extensively screened and about which researchers believe they already have reliable knowledge. However, working with small farmers in marginal environments makes for unpredictability and so many practitioners of participatory learning in PPB have found themselves drawn inexorably into participatory research, because their varietal demonstration trials did not produce the expected results.

Participatory research is a family of approaches that enable participants to develop their own understanding of and control over the processes and events being investigated. It is based on the principle that greater understanding and ownership of information, as well as capacity to make use of it, results from being involved in its generation. Essentially, participation converts information into knowledge. In contrast to participatory learning, all the people involved in participatory research, including the scientists, have hypotheses but no *a priori* knowledge of the expected outcomes of experimentation. The experimental process is undertaken in conditions of mutual uncertainty and shared risk. Participatory research in PPB typically involves farmers in one or all of the following: establishing breeding objectives, identifying desirable traits so as to design plant ideotypes, selection of parents, selection in early generations and screening of advanced lines. Scientists and farmers bring very different kinds of complementary knowledge and expertise to PPB but they have a common goal of testing hypotheses - to answer questions to which neither know the definitive answer. Participatory *action* research has the added objective of enabling the participants to act more effectively based on their own improved understanding. Indeed, action to change the situation being researched may be the best or only way to carry out the " experiment. " By changing the situation, the action enables the investigators to better understand how to make future interventions. Although widely used in health, education and policy research, participatory action research is only just beginning to be appreciated in agricultural research circles and to date there are very few examples of its use in formal research programs.

Types of Participation and Impact

There is an enormous variety of methods and tools used in common by participatory learning, participatory research and participatory action research. For the purpose of addressing the question "does participatory research work?" the important distinction is not so much the method or tool, but rather the objective for which the participation is sought, or the type of impact aimed for (Johnson et al, 2003). Participatory approaches are being incorporated into plant breeding to address a variety of objectives. Widely seen as having advantages for use in low yield potential, high stress environments, PPB is most often applied when specific adaptation is sought., although some practitioners argue that both specific and wide adaptation are possible (see for example, Staphit and Subedi,1996). PPB may be applied to provide rapid, frequent feedback about farmers'varietal preferences to breeders, to speed up the breeding process and accelerate rates of adoption. PPB may have *in situ* conservation as a goal. In addition, PPB may have social goals such as benefitting disadvantaged beneficiary groups such as women and the poor, empowerment of farmers, protection of farmers'rights, and improving equity in access to new varieties.

For this reason, it is important to discriminate among different types or modes of participation, which are not necessarily mutually exclusive although there may be trade-offs among the impacts of the different types. Building on several different definitions of modes of participation (Biggs and Farrington, 1991; Pretty,1994) L ilja and Ashby (1999[a], 1999b) constructed a typology for empirical analysis of PPB approaches based on who makes decisions at different stages of the research process. The typology defines two groups of decision makers: "scientists" which include research programs and extension agencies; and "farmers" which refers the intended users of the PPB varieties, and may include consumers, traders and processors.

- Conventional (no farmer participation): " scientists" make the decisions alone without organized communication with "farmers."
- Consultative: scientists make the decisions alone but with organized communication with farmers. Scientists know about farmers' opinions, varietal preferences and priorities through systematic one-way communication with them Scientists may or may not factor this information into their decisions. Decisions are not made with farmers nor delegated to them
- Collaborative: decision-making: authority is shared bewteen farmers and scientists based on organised communication between the two groups. Scientists and farmers know about each others ideas, hypotheses and priorities for the research through organized two-way communication. Plant breeding decisions are made jointly, neither scientists nor farmers make them on their own. Neither party has the right to revoke or override the joint decision.
- Collegial: farmers make plant breeding decisions collectively either in a group process or through individual farmers who are in organized communication with scientists. Farmers know about scientists' priorities and research hypotheses through organised on-way communication. Farmer may or may not let this infromation influence their plant breeding decisions.
- Farmer experimentation: (no scientist participation). Farmers make the decisions either in a group or as individuals on how to experiment with and introduce new genetic material without organized communication with scientists.

These are "ideal types" of participation which lie along a continuum in which the farmers are progressively more empowered, ranging from conventional in which there is no farmer empowerment, to farmer experimentation in which there is no scientist empowerment. In practice any given PPB project or program seldom employs only one type but instead combines several. Farmers may contribute knowledge and information, as well as genetic materials and they may be actively involved in the breeding process.

One of the most critical differences among the many different mixtures of participatory research approaches in use is how *early* in the breeding process farmer participation is sought, and this in turn is related to the objective of the participation which as noted, defines the kind of impact that can be obtained. In the typology described above, (Lilja and Ashby, 1999) divide the innovation process into three stages: design, testing and diffusion. In formal plant breeeding and in PPB (Weltzein et al, 2003) these stages roughly correspond to:

(a) Design: setting breeding goals and generating variability. Decisions are made about basic parameters of variety type (s), preferences, user needs. In most programs this stage involves designing and making crosses between diverse parents with complementary trait combinations. It may involve building base populations for cross-pollinating crops or the generation of new progenies for testing.
(b) Testing. In plant breeding decisions are made about how to narrow down the new variability achieved in the design stage from several thousand to a few hundred progenies or clones (in the case of vegetatively propagated crops) and includes selection in segregating generations in self-pollinated crops. In population improvement schemes this is the progeny testing stage. In plant breeding this stage includes the testing of experimental materials on-station and increasingly, on-farm. This testing looks for desired productivity traits, adaptation and acceptability, usually in replicated plots over a range of locations with increasing plot sizes. Testing continues until varieties are proposed for release.
(c) Diffusion. This includes varietal release, demonstration under farmer management on farms, the identification of a seed production and distribution system. Although this stage goes beyond the purely technical breeding process, especially in poor countries the seed system may present a bottleneck to eventual impact that needs to be taken into consideration early in the design stage.

Who makes decisions and at what stage in PPB can lead to different outcomes and impacts. For example, if farmers have decision-making participation in the design stage, contribute genetic materials and are actively involved in the breeding process this can influence overal breeding priorities. Additionally, there may be changes in parents and crosses, and ultimately the variability on which the next stage of PPB will be built. If farmers have decision-making participation in the testing stage and evaluate fixed lines, the varieties produced and impacts may be different from those identified when farmers are involved in the design stage. At the diffusion stage, farmers may be able to make decisions about when, where and with whom varieties are demonstrated and multipled for seed. This may materially influence how many farmers ultimately get the varieties, but of course farmer particpation at this stage will not affect the kinds of varieties available to them.

Hypotheses about "what works" in participatory research

In order to systematically compare different experiences with PPB and to tease out the impact of participatory research on the breeding process and its outcomes, it is useful to situate examples within a framework that allows for direct comparison of the type(s) of participation and stages in the breeding process at which these are being implemented, along with a comparison of the objectives for which participation is being sought. A framework for comparison like this is needed in order to avoid the problems of making inferences and drawing conclusions based comparing completely different types of participation for which disimilar outcomes might reasonable be expected. The frame work used for this comparison is illustrated in Table 1[3]

Once different types of participation and stages in the innovation or in this instance, the breeding process, are differentiated then the types of impacts these are associated with need to be identified. The impact we are interested in is the impact of the use of participatory research on the breeding process and on its outcomes. Three classes of impact can be distinguished: process impacts, adoption impacts and development impacts. Process impacts refer to the ways in which the use of a given mode of participation at a given stage of the breeding process affected how the research was carried out. Adoption impacts refer to the rate and geographical scope of the adoption of new varieties, which in turn reflect how well adapted and acceptable these varieties are to farmers. Development impacts refer to the size of benefits of growing new varieties as well as the distribution of benefits among different welfare groups, such as growers and consumers, the poor and women.

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[3] This paper draws on a wide range of reported case studies of PPB both published and unpublished. Many have been surveyed to obtain expert opinion from PPB practitioners with a questionnaire distributed to over 150 projects using PPB, and in addition form part of an inventory of cases complied by the CGIAR systemwide program on participatory research and gender analysis (PRGA Program) in close association with the members of the PRGA's international working group on PPB. This information is publically available and can be consulted on the Program's web site (PRGA 2004) *http://webpc.ciat.cgiar.org:8080/prgainventory/servlet/prgaInventory.InvListServlet?inv=PPB&list_theme=0&list_count=0&list_crops=0&list_resour=0&list_reg=0&list_cgcenter=0&sp=0*.
Most of the studies drawn on for this analysis were not therefore, designed to provide a formal impact asessment of "what works" in PPB . This means there are two shortcomings in the analysis. First, the absence of a counterfactual: in order to make inferences about whether PPB" works" ideally we would compare it with conventional breeding that did not use participatory methods. Most studies do not include a formal "with and without" PPB comparison, but where this is available it is noted. The establishing a counterfactual "without PPB"case in practical terms very difficult because "conventional"(non – participatory) plant breeding follows a very different breeding process.Secondly, selection bias is an issue in any analysis where the treatment groups are not randomly selected. When PPB programs choose to work with specific farmers or communities, they may do so in a way that may influence the observed impacts. For example, they may work with more educated farmers. Then impacts attributed to PPB may in fact be due to farmers' education. Furthermore, PPB efforts that fail to perform better than conventional breeding may be under-reported in the literature.

Table 1: Types of participation used in PPB : illustrative cases[4]

Type of Participation	Design stage	Testing stage	Diffusion Stage
Consultative	Various crops, Northwestern India (Joshi and Witcombe, 1996); Rice, Nepal (Staphit, 1995a,1996); cassava,Colombia(Iglesias et al, 1990;Hernandez-R,1993); Barley, Syria (Ceccarelli, 2000; Aw Hassan and Lilja, 2002);	Potato , Bolivia(Thiele et al, 1997 and Carrasco 1997);Beans Rwanda(sperling and Sheidegger, 1996);Potato, Ecuador,(Andrade and Cuesta, 1997); Maize, Ghana Grains Development Project (Morris et al, 1999); Maize, Mali(Kamara et al, 1996; Defoer et al 1997); Beans, Cameroon, Kitch et al nd Rice, Dalton 2003, 2004. Dalton and Lilja (1997); Lilja and Erenstein 2002	
Collaborative	Segregating bean populations in Colombia (Kornegay et al 1996); Maize in Honduras, (Gomez et al.1995; Gomez and Smith ,1996);Pearl Millet, Inda (Dharmotharanet al 1997;Weltzein et al, 1998);	Beans in Tanzania(Butler, 1995); Maize, Mali (Kamara et al, 1996;Defoer et al 1997)	Various crops, Worl d Neighbors, Andean region (Ruddell,1994)
Collegial	Pearl millet, Namibia (Ipinge et al 1996; Lechner,1996;Bidinger, 1998); Maize , Honduras(Gomez et al 1995) ;	Various crops,and countries in Latin America CIALs (IPRA, 1995); Maize, PTA Brazil(Cordeiro, 1993); Maize, Ethiopia, (Negassa et al 1991)	
Farmer experimentation	Rice, Philippines –CONSERVE (Berg and Alcid, 1994;)	Various crops, BBA in India(Kothari, 1997);	Maize , China (Song 1998); Community seedbanks, Ethiopía (Berg 1993;)

This short conference paper does not allow space for full analysis which is the subject of another work in progress(Ashby and Lilja, 2004). Here we restrict the analysis to presenting a few selected cases which enable us to say something about how breeding outcomes and impacts were affected by the use of participatory research in response to the following hypotheses which were elaborated by the PRGA plant breeding working group and have been used to guide their work and related impact studies since 2000(PRGA, 2000). We cite both expert opinion and data from impact studies to illustrate types of impact. The expert opinion is subject to bias because practitioners may see their own work in a more favorable light than is objectively the case. However, this opinion illustrates both the experience and the expectations of practitioners participatory research "works."

- Participatory research (PR) increases the benefits and is more effective at reaching women and the poor
- PR improves research efficiency
- PR leades to more acceptable varieties and accelerates adoption
- 4. PR leads to changes in costs that do not lower cost benfit ratios and may improve these

Examples of Participatory Research in Plant Breeding and its Impact.
Participatory research (PR) increases the benefits and is more effective at reaching women and the poor. There is considerable evidence that using participatory approaches improves the acceptability of bred varieties to disadvantaged farmers by including their preferences in criteria for developing, testing and

[4] . The cases included in Table 1 are not an exhaustive list but include most of the well-documented cases. . The inclusion of a case in a given cell of Table 1 indicates that it included the use of a particular mode of participation at a given stage in the breeding process, and the documenttaion of the case included some evidence that allows us to make some inferences about the impact of using this approach. This does not mean that this mode of participation is the only or even the predominant one used throughout the breeding process in this case.

release of new materials.[5]To begin with we cite expert opinion from the survey conducted by us for PRGA of over 150 projects using PPB and illustrated in Figure 1: for example, 55 percent reported that PPB improved the project's effectiveness in targeting the poor.

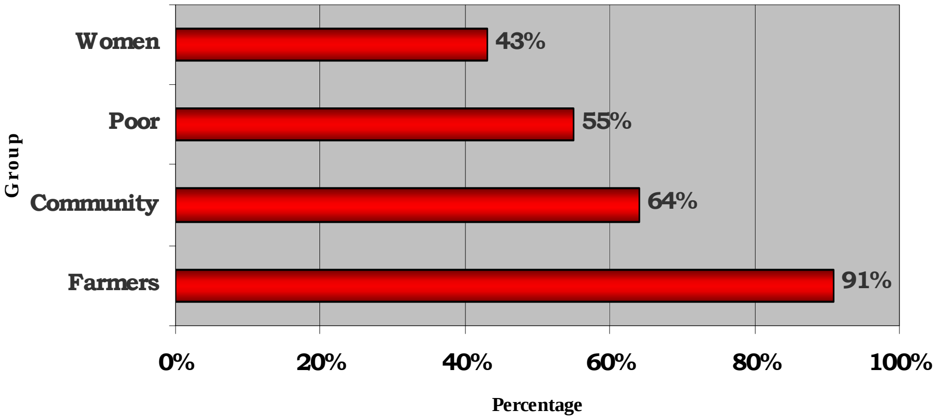

Figure 1: Opinion of PPB practitioners about beneficiary groups targeted.

A specific example is the WARDA program conducted in 17 countries using consultative participation in the testing stage: 69% of national program researchers considered that by consulting women and involving them in varietal evaluation, the program had included varietal traits that women know about, and especially gender-related varietal preferences, leading to better acceptablity and faster adoption of the varieties. These results are documented in several publications (Lilja and Erenstein, 2001). An economic analysis of PPB barley breeding in Syria is consistent with opinion that PPB increases the benefits to resource poor farmers from plant breeding. Total estimated discounted research induced benefits to Syrian agriculture were estimated comparing conventional and three different PPB approaches, based on a rigorous comparison using experimentally-generated data on yields. Benefits from conventional breeding were estimated at US $21.9 million. Benefits estimated for the three PPB approaches ranged from US $ 42.7 million to US $113.9 million. The difference is attributed to the yield advantage of PPB varieties (a 26% difference) and to the reduction in the amount of time it took for PPB varieties to get into farmers fields, discussed in more detail below(Lilja and Aw Hasaan, 2002). Another example is the involvement of women farmers in the development of maize seed systems in China that resulted in (a) a broadened national maize genetic base (b) improved maize yields and (c) strengthened womens' organizations (Song, 1998).

PR improves research efficiency.
One of the eficiency gains from including partiicpatory approaches in plant breeding is based on the extent to which breeding priorities or research practices are reoriented in ways that save time and/or money.
Here to it is useful to first look at expert opinion from the PRGA survey: 82% of the the respondents concluded that PR led to the formation of feedback links and 54% considered that this led to changes in priorities. Another 75% considered that PR led to a change in breeding methods.

However, the changes noted do not necessarily translate into a more efficient research process. A case study that examines this hypothesis in depth is one conducted by the ICARDA Barley Breeding program in Syria. A rigorous comparative study with controls(Ceccarelli, 2000) defined efficiency as the number of high yielding varieties identified by different approaches, and found that the breeder was more efficient than farmers in selcting on station under high rainfall conditions but that farmers were more efficient under stress conditions. A t-test of significant difference showed that farmers' selections are as high yielding as breeders' selections. Further study, which took the same breeding population and developed varieties with different approaches to compare participatory and non-participatory breeding, found that by

[5] Many studies show how participatory approaches clarify where there is agreement between breeders and farners on desirable traits and where resource farmers rank varieties in order of preference differently from breeders(Pearl Millet, Namibia, Monyo et al 1997; Beans, Ethiopia, Mekib, 1997; Maize, Mali, Kamara et al. 1996;Defoer et al, 1997; cowpea, Cameroon, Kitch et al nd; Beans, Tanzania, Butler et al, 1995; tree species,Burundi, Frankel et al. 1995; beans, Rwanda, Sperling et al,1993; potatoes, Rwanda, Hagerud and Collinson, 1990; beans, Colombia, Ashby et al, 1989; Ashby, 1986; rainfed rice, India Maurya 1988). However, although participatory approaches can increase both the benefits of plant breeding to disadvantaged groups and the proportion of the disadvantaged who adopt, it should not be expected that these benefits will necessarily be distributed equitably between rich and poor farmers as a result of PPB.

introducing farmer participation at the design stage (in Year 3 of the breeding program) a three year reduction was achieved in the time taken from initial crosses to release. PPB made certified varieties available by year 6 compared to year 9 in the conventional breeding program (Lilja and Aw Hassan 2002).

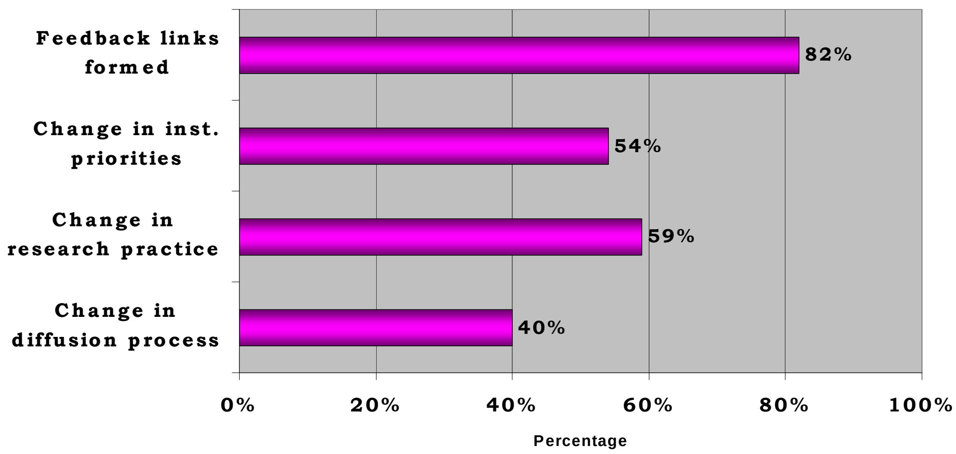

Figure 2: Expert Opinion on Changes in the Breeding process due to PR

In another example, breeeders concluded that it was faster, less expensive and more reliable to involve farmers directly in the identification of promising accessions for use in the breeding program. Farmer participation in screening the entire pearl millet germplasm accessions from Namibia (numbering about 1000) proved very efficient in generating some basic information as when farmers recognized three major classes of materials with different clusters of desirable traits, and assisted breeders to come up with the desired pearl millet ideotype for Namibia. Breeders introduced material corresponding to the ideotype into farmers trials and because millet is cross-pollinated, the frequency of the desired traits increased in local germplasm through introgression. Farmers began selecting outcrosses to provide seed for the following season and after four years, breeders selected plants from a farmer field. These plants were intercrossed with 30 varieties selected on-station by farmers from specially designed, elite and morphologically diverse nurseries, to create a PPB composite population named MKC. MKC was far superior to the local germplasm and to another population NC 90, developed by conventional breeding (Monyo et al, 1997) .

Efficiency gains depend also on the extent to which farmer involvement enables the breeding program to improve targeting and so minimise its investment in the development of varieties which turn out after release, to be only minimally interesting to farmers.This represents a saving both to the research program and to the farmers who will otherwise expend resources on trying out new varieties before rejecting them. Some PPB programs develop where there is no adoption of improved cultivars, and inapropriate cultivars are being recommended (Joahi and Whitcombe, 1996).New Rice for Africa (NERICA) implemented by WARDA, the African Rice Centre, illustrates these new crosses combine the ruggedness of local African rice species with the high productivity traits of Asian rice. NERICAs were generated by a technical and social research process. The program used participatory approaches to evaluate new varieties with men and women farmers, and helped to identify cost-saving production, grain processing and consumption traits in addition to yield-related characteristics, valued by men and women. Results from Cote d'Ivoire show that failing to include gender-differentiated production and consumption traits and focusing on the wrong attributes leads to biased and inappropriate varietal promotions. Evaluating new varieties only on yield-related characteristics (often gender-neutral) will lead to 19% of all varieties mis-categorized as superior whereas incorporating gender-differentiated traits (labour-related, consumption, post-harvest) reduces mis-categorization and increases adoption potential. (Dalton 2003 and 2004; Lilja and Dalton, 1997).

PR accelerates adoption

The incorporation of participatory approaches consistently enables breeding programs to "break through"adoption bottlenecks caused by low levels of acceptability of new varieties to poor farmers. An example of poor acceptability is Ethiopia where it is reported that by 1997 over 122 varieties of cereals, legumes, crops and vegetables had been released but only 12 varieties had been adopted by farmers (Mekib,1997). A large scale example of adoption impact is the program carried out in four departments of the North East of Brazil by EMBRAPA with farmer committees. After years of non-adoption, once PPB was implemented several clones which were both resistant to root rot and highly acceptable to farmers were released (Fukuda and Saad, 2001). The study conducted in Syria also provides evidence of accelerated adoption. A farmer survey found on the average that a 26% difference in yield between PPB varieties and conventionally bred varieties was reported by farmers; farmers were planting 69% more area to PPB than conventionally bred varieties; and were willing to pay more for seed of PPB varieties (Lilja and Aw Hassaan, 2002). In Ghana, maize breeders had released several modern varieties(MVs) which had poor acceptance and were not widely adopted. Subsequently, new experimental materials were screened in researcher-managed trials and by farmers in on-farm trials. The outstanding materials jointly selected were subjected to several additional cycles of selection and improvement by breeders and then released. Farmers were involved with researchers and extensionists in planning strategies for transfer. Overall adoption of MVs increased to over two-thirds of Ghana's maize farmers, and nearly sixty percent considered their yields had increased (Morris et al, 1999) . The results from another case study of adoption are shown in Figure 3. This study compared matched communities with and without farmer-led PPB interventions in the form of farmer research committeee or CIALs whcih carried out varietal selection with their communities. Fortuitously, in this instance the CIALs selected the same bean variety as the conventional breeding program and made seed available in their communities in the same year that the variety was released by the national program. However, certified seed from national program sources did not get to the PPB villages from the official sources during the same period enabling the study to compare adoption rates of the same variety in two different varietal development processes. As Figure 3 shows, communities with PPB had a much faster rate of adoption and this spilled over onto their neighbors.

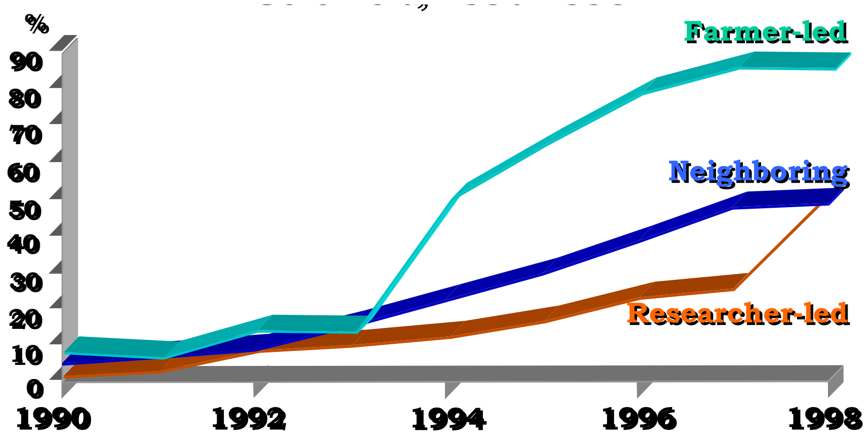

Figure 3 : Dissemination of a farmer –selected bean variety in Colombia, 1990-1998.

PR changes cost structures of breeding

One of the main concerns of conventional breeding programs about the inclusion of participatory approaches into their portfolio of breeding methodologies is that PR looks very time intensive and therefore costly. Many aspects of PPB seem likely to increase costs: on farm testing begins earlier, more seed is needed of experimental varieties, the trials are dispersed outside the esperiment stations, different kinds of personnel may be needed to interact effectively with farmers. Typically, farmers need to be transported to experiment stations or regional trials and a good deal of time spent in interaction with them there and on farms to involve them at the design stage. Expert opinion reflects this debate : 26% of respondents to the survey said costs increased, while 45 % said they stayed the same or went down, and 29% were unsure. In the case study of a high altitude rice in Nepal Staphit and Subedi (1996:2) considered their combined PVS and PPB approach cost-effective because the parents and segregating products were "piggybacked" off the ongoing formal breeding process. Farmers were given still segregating (F5) bulk families harvested from the most promising F4 rows, for evaluation in their fields. There were important differences in the ways farmers and breeders tested the materials. The preferred cultivars subsequently developed with farmers were widely adopted within three years. The study of barley breeding that compared PPB and conventional approaches provides some important insights on this issue. In this case, the operational costs of the program increased due to PPB which included costs of work off station in Syria and in several other countries. However, operational costs are only 23% of the total budget. Overall, the total annual budget went up by 3%, approximately US $26,000. (Lilja and Aw Hassaan, 2002). This cost has to be seen against the savings incurred by getting varieties out to farmers three years earlier using PPB. Clearly more analyses of the way PPB affects costs would help to settle this debate, but at present we cannot conclude that PPB necessarily represents a major increase in cost for a breeding program.

Conclusions

Participatory research approaches that involve clients in the process of enquiry are widely practised today in many different branches of agriculture ranging from integrated pest management to applied biotechnology. In this paper we have focussed on participatory plant breeding to show how participatory research increases benefits and is more effective at reaching women and the poor. We have also seen how PR improves research efficiency and leads to more acceptable varieties thus accelerating adoption. This is probably the most compelling incentive for researchers to use this approach. We also saw how PR leads to changes in costs that do not lower breeding program cost benefit ratios and may improve these. PR is recognised in the CGIAR system as an important complement to conventional plant breeding as testified to by a review of plant breeding by the CGIAR Technical Advisory Committee in 2000 which recommended that programs should include participatory approaches as an organic part of their portfolio of methods. The impact found for PR in plant breeding is just one example that can be drawn on to answer the question “Does participatory research work?” The evidence shows that a careful choice of research goals, targeting of environments and selection of user communities is required. In addition a systematic understanding of different types of participation is needed to select appropriate PR techniques and tools. PR is not a magic bullet that will persuade recalcitrant non-adopters to take-up a researcher’s favorite technology. PR or client-driven research when used appropriately and expertly, is a proven complement to conventional non-participatory research approaches that is increasingly recognized and practised as an integral part of modern innovation systems.

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