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Measuring the impact of user participation in agricultural and natural resource management research

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Abstract

Persistent poverty and environmental degradation demand a constant effort to improve the effectiveness and impact of agricultural and natural resource management research. Participatory research methods have developed as a way to help researchers better target their work towards the needs and constraints of specific stakeholder groups. Participatory research may also strengthen the capacity of participants to initiate a continuous process of innovation. The capacity of farmers and other end users of technologies to innovate may be particularly important in poor, marginal environments where conditions are highly variable. This paper assesses the impact of using participatory methods in three agricultural research projects which have a natural resource management focus. Mixed methods are used to assess technological, economic, human, and social impacts and the cost implications of incorporating beneficiaries into the research process. User participation was found to influence priorities and practices within and beyond the specific projects studied. Participation led to more relevant technologies and greater economic impacts, especially when participation was early in the research process. Impacts on farmer capacity were high when farmers worked intensively with researchers over a period of time. Use of participatory methods changes research costs. When farmers took over tasks that were previously done by researchers, some of the research costs were transferred to farmers. When participatory methods were combined with conventional on-farm research, there were also start-up costs, because researchers and farmers needed to learn

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new research methods. However these additional one-time costs were not significant in terms of total research costs.

Keywords: Participatory research; Impact; Agricultural and natural resource management

1. Introduction

Agriculture is an important component of the livelihoods of most rural poor people in developing countries. Poor farmers are often trapped in situations where they are degrading their natural resources and lack access to more productive and sustainable technologies. One reason for this is that available technology is often unsuitable for them given their objectives and constraints. Hence empowering these farmers to influence the kinds of technologies that are being developed has the potential to enhance the contribution of agricultural research to productivity, sustainability, and, ultimately, poverty alleviation.

Although the ideas of researchers working intimately within communities emerged earlier, it was in the 1970s when participatory research became a formally recognized methodology. Participatory research methodology does not have a simple linear history. Many versions of participatory research have emerged over the past three decades; the two noticeable common characteristics are that the methods involve continuous learning (‘‘action learning’’) on the part of all participants, and they minimize the ‘‘distance’’ between researchers and end users through dialogue and action. Today, a growing number of researchers are attempting to better focus their research on the priorities and constraints of the poor by incorporating them directly into the research process. Participatory research is no longer a marginal activity among the Future Harvest[1] agricultural research centres; collectively they report investing significant human and financial resources in projects that use participatory approaches. In 2001, centres spent US$65 million on 144 participatory projects, involving 145 scientists, 89 PhDs and 56 at the Ms level (Ashby, 2001).

Scientists have documented the benefits of participatory natural resource management research in a number of case studies (e.g., Hinchcliffe et al., 1999, Buenavista et al., 1998, Sanginga et al., 2002). However, the impacts and costs of using participatory as opposed to more conventional approaches are rarely systematically analyzed or reported. Until we have a better understanding of the tradeoffs associated with using participatory methods, appropriate scaling up or institutionalization of participatory approaches will be difficult within agricultural and natural resource management (NRM) research institutions.

The objective of this study is to contribute to better decision making about the use of participatory methods by analyzing what difference they made in three research and development (R&D) projects. Participation is hypothesized to impact projects in

[1] Future Harvest is a network of 16 international agricultural research centres whose objectives are to alleviate poverty and sustain the environment (www.futureharvest.org).

four areas: (1) adoption and economic impact of project technologies, (2) human and social capital among participating individuals and communities, (3) feedback to formal research institutions and (4) the costs of conducting the research. The following section describes the conceptual framework for analyzing the impact of participation in research. Section 3 explains the empirical methods and data used for the analysis, including details of the three case studies. Section 4 presents the results for each of the hypothesized impacts, and Section 5 concludes with a discussion of the main findings and their implications for current and future research and development activities.

2. Conceptual framework

A large and growing number of participatory tools and methodologies exist (e.g. PRGA project inventory, 2002). For the purposes of assessing impact however, what is important is not so much the specific tool used but rather what it was used for, the objective for which user participation was sought. One argument for involving potential users or beneficiaries in the development of technology is to obtain feedback necessary to produce a technology that is appropriate and therefore likely to be adopted. User participation with this objective is often referred to as "functional participation" because it is concerned with increasing the efficiency and effectiveness of the existing innovation process (e.g. Pretty, 1994; Ashby, 1996).

There is also a school of thought that argues that the real benefits of participatory research are not realized through the development of specific technologies but rather through the transformation of innovation processes. By empowering rural people with the capacity and tools to innovate and to influence research agendas, participatory research can lead to fundamental changes the nature of the innovation process, bringing in new actors and altering existing power relationships. User participation with this objective is often referred to as "empowering" (e.g. Okali et al., 1994; Mikkelsen, 1995; Ashby, 1996). Functional and empowering participatory approaches are not mutually exclusive although there may be tradeoffs among the impacts of the two types of approaches.

Biggs and Farrington (1991) defined five "modes" of participation. Lilja and Ashby (1999a) adapted the five modes of participation to construct a typology which was designed for empirical analysis of participatory research projects based on who makes decisions at what stage of the research process. The typology defines the two groups of decision-makers: "scientists" which include outside agencies, extension systems, or formal research agencies; and "farmers", which includes intended users or other beneficiaries:

(1) *Conventional (no farmer participation):* scientists make the decisions alone without organized communication with farmers.
(2) *Consultative (functional participation):* scientists make the decisions alone, but with organized communication with farmers. Scientists know about farmers' opinions, preferences, and priorities through organized one-way communication

with them. Scientists may or may not let this information affect their decisions. Decisions are not made with farmers nor delegated to them.
(3) *Collaborative (empowering participation):* decision making authority is shared between farmers and scientists, and involves organized communication among them. Scientists and farmers know about one another's opinions, preferences, and priorities through organized two-way communication. The decisions are made jointly; neither scientists nor farmers make them on their own. No party has a right to revoke the shared decision.
(4) *Collegial (empowering participation):* farmers make the decisions collectively in a group process or through individual farmers who are involved in organized communication with scientists. Farmers know about scientists' opinions, preferences, proposals, and priorities through organized one-way communication. Farmers may or may not let this information affect their decision.
(5) *Farmer experimentation (no researcher participation):* farmers make the decisions individually or in a group without organized communication with scientists.

"Who makes decisions" clearly has the potential to effect both the specific decisions that are made within a project as well as the knowledge and skills gained by participants. The scope of impact may also be conditioned by when in the research process shared decision making occurs. Lilja and Ashby divide the innovation process into three stages—design, testing, and diffusion. In the *design stage*, problems or opportunities for research are identified and prioritized, and potential solutions to priority problems are determined. The outcome of the decisions made at this stage is an array of potential solutions. Potential solutions are evaluated in the *testing stage*, and decisions are made about which solutions to test, who does the testing, where and how it is done, and how the results are interpreted. Outcomes at this stage could result in a return to the design stage or in the identification of technologies for mass distribution at the *diffusion stage*. Diffusion involves building the awareness of recommended solutions among future users. It involves decisions about when, to whom, and in what way to distribute technologies, supply new inputs, and teach new skills to potential users.

Different types of farmer participation at different stages of the innovation process can lead to different impacts.[2] For example, participation at the design stage can influence overall project priorities, and help ensure that a project is appropriately focused from the start. Because of the implications for activities and budgets, sharing authority with users at this stage could enhance users' sense of empowerment and ownership of the process. Participatory research at the testing stage can help identify the best option from a pre-defined set of solutions to a given problem. If users gain training and experience in the design, implementation and evaluation of experiments, their capacity for innovation can be substantially increased. At the diffusion stage, user participation adds little to the actual technology, and to the extent that a technology can "sell itself", participation would not be expected to

[2] For a comprehensive set of impact hypotheses by type of participation and stage of the research process see Johnson et al. (2001, pp. 5–8).

influence outcomes. However, when the success of a technology depends on how it is distributed and promoted, including complementary programs and policies, user participation can make a significant difference to outcomes.

User participation at any stage of the research process can provide important information to researchers, however the nature of the information may depend on the stage. At the design stage researchers learn about user priorities, while at the testing stage they learn about their technical knowledge and criteria for evaluating specific technologies. At the diffusion stage researchers learn about the factors that conditions farmer's awareness of and access to new technologies.

3. Empirical methods and data

3.1. Empirical methods and challenges

Assessing multiple impacts requires multiple assessment methods. In this study, the influence of participatory methods on the adoption and the economic impact of a technology—defined as technology impacts—were assessed using conventional adoption/adoptability studies and econometric analysis, complemented by qualitative data from interviews with farmers. The impact of participation on human and social capital among participants and on the feedback links between users and formal research—defined as process outcomes—was generally assessed qualitatively on the basis of interviews with key informants within and outside of the project, and focus group meetings in project and non-project communities. The cost implications of using participatory methods were assessed using project financial data, interviews with project staff, and secondary sources.

Since the goal of this analysis is to look not at total project impact but rather at the incremental impact associated with user participation, careful attention was paid to defining the counterfactual. When assessing cost and technology impacts, the counterfactual was a conventional research/extension scenario that did not use participatory methods. In some of the cases, the participatory methods were either not part of the original project plan or resulted in major changes in project activities. In these cases, we had enough information to use the original project plan to construct a hypothetical counterfactual. In other cases, we identified an appropriate comparison with a project that addressed a similar problem using non-participatory method. We assumed that non-participatory projects do not have process outcomes for farmers since by definition these result from the interaction of researchers and farmers. Therefore, in assessing process outcomes, we limit ourselves to documenting impacts and establishing causality.

The issue of causality raises another important empirical issue that merits discussion in the context of this study, the problem of selection bias. Selection bias is an issue in any analysis where the treatment groups are not randomly selected. When research projects choose to work with specific individuals or communities, they may be doing so for reasons that may also be associated with the observed impacts. For example, interventions based on local participation are often implemented in communities that have high levels of social capital. Failure to account for this could result in a project taking credit for high levels of social capital when in fact social capital contributed to the project's success. In a community without high levels of social capital, the very same project might have much less impact. Selection bias can be controlled with detailed data from a large sample of project and non-project communities. This is often not possible however, and researchers need to be careful about interpreting and extrapolating results beyond a project site. Selection bias is also likely to be present at the level of project participants. Where participation is voluntary, people can choose to participate or not. In any given situation, the people who choose to participate are likely to be different from those who choose not to do so. First and foremost, participation takes time, which means that the poorest may not be able to afford it. Cultural, social and political norms may also influence who has the opportunity to volunteer; marginalized groups such as women and minorities may be excluded. The nature of the project activity also influences who participates. For example, the type of individual who volunteers his or her time to be part of a local agricultural research group is likely to be someone who already experiments or at least has an interest in experimentation. Controlling for selection bias among participants is especially difficult since selection criteria are largely unobservable and uncorrelated with observable characteristics such as age, education, or income. Extrapolation of impacts from self-selected participants to the broader population may not be appropriate.

3.2. Selection of cases

Three cases were selected for analysis of the costs and impacts of incorporating farmer participation in agricultural and NRM research. The cases were drawn from an inventory of 83 natural resource management research cases compiled by the PRGA Program during early 2000 (PRGA Program Inventory, 2002). The main selection criterion was that the project had been in operation long enough to have generated observable intermediate or final impacts. The NRM focus made this difficult since NRM-focused research is relatively new within agricultural research centres, and its impacts often cannot be observed in the short term. Additional criteria included potential for collaboration on the part of participants and implementing organizations, and logistical issues. The projects selected are described below.

3.2.1. The Centro Internacional de la Papa (CIP)[3] development of integrated crop management (ICM) technologies and practices for farmer field school (FFS) for sweetpotato in Indonesia (1990s)

During 1995–1997, CIP, with support from UPWARD,[4] and in collaboration with public and private sector groups, implemented a project to develop a protocol

[3] CIP (http://www.cipotato.org/) a Future Harvest Centre headquartered in Lima, Peru, conducts research internationally on potato and sweetpotato.

[4] The Users' Perspectives for Agricultural Research and Development (UPWARD) is a CIP-affiliated network of Asian researchers conducting participatory R&D projects in root crop systems.

for a sweetpotato ICM-FFS in Indonesia. Collaborators were Mitra Tani, a local nongovernmental organization (NGO); the National Research Institute for Legume and Tuber Crops; and Duta Wacana Christian University. Project activities were implemented in major sweetpotato growing areas in East and Central Java, where it is grown as an important cash crop throughout the year, mostly in rotation with rice. The project strategy relied on participatory approaches and methods at all stages: needs assessment and project design; R&D of ICM technologies and practices; design of farmer learning protocols applying the FFS approach; pilot-scale implementation of the sweetpotato ICM–FFS; and monitoring and evaluation. Different participatory methods and tools were used, but one of the major and most innovative approaches was the selection of a group of eight farmers who worked alongside project staff throughout the project. They helped set priorities, design and implement trials, and design the curriculum for the ICM–FFS.

To institutionalize the sweetpotato the ICM–FFS model that was developed, and allow for large-scale farmer learning and implementation, staff from the National IPM Program (NIPMP) and 30 local NGOs underwent FFS facilitators' training; NIPMP staff in June 1997, NGO staff in April 1998. These local extension organizations implemented and funded follow-up programs, and a second research project was initiated to evaluate their activities during a 2-year period (1998–1999). Mitra Tani carried out the evaluation work, with methodological and financial support from CIP and UPWARD.

3.2.2. The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)[5] work on models for the participatory testing of soil fertility technologies in Southern Africa (1990s)

The ICRISAT Mother–Baby trial model is an upstream participatory research methodology designed to improve the flow of information between farmers and researchers about technology performance and appropriateness under farmer conditions (Snapp, 1999). The methodology was initially developed and implemented to test legume-based soil fertility management technologies in Malawi, and was later expanded to Zimbabwe. The trial design consists of two types, mother and baby trials. The mother trial is researcher-designed and conforms to scientific requirements for publishable data and analysis. A baby trial consists of a single replicate of one or more technologies from the mother trial. A single farmer manages each baby trial on his or her own land. A typical implementation of the methodology would include a single mother trial and numerous baby trials within a village. The MB trial methodology has three goals. The first is to generate data on which to assess technology performance under realistic farmer conditions. The second is to complement the agronomic trial data with farmers' assessments of the adoption potential of technologies. This information helps researchers understand how the technologies fit into farmers' broader farming and livelihood strategies. The third goal is to encourage farmers to actively participate in the trials, and is expected

[5] ICRISAT (http://www.ICRISAT.org) conducts agricultural and natural resource management research for the dry tropics.

to stimulate farmer experimentation with, and adoption of, new technologies and practices.

3.2.3. World Neighbours (WN)[6] soil conservation work in Honduras (1980s and early 1990s)

This project, supported by WN, the Coordinating Association of Resources for Development (ACORDE) and the Ministry of Natural Resources of the Government of Honduras, promoted improved soil conservation practices in south central Honduras from 1981 to 1989. The project worked in 41 communities in three municipalities—Guinope, San Lucas, and San Antonio de Flores—in the state of El Paraiso. The project's approach went beyond strictly increasing agricultural productivity through the adoption of soil conservation practices, to improving economic, social, and ecological conditions via agriculture (Plan del Programa). Although the project was primarily focused on development, it had a significant capacity building and research component, teaching farmers the principles of soil conservation technologies, training them to experiment and adapt technologies, and imparting knowledge about selection and improvement of genetic materials for green manure. The project carried out these activities in the context of community groups, and trained local farmers to take over extension jobs after several years. The purpose of these activities was to build social as well as human capital, strengthening organizational capacity and the capacity and commitment to share knowledge within the community. The project methodology was that described in Bunch (1982) that advocates a combination of 80% practical training and 20% theory. Significant increases in adoption were observed in the study areas during the course of the project. According to World Neighbours' reports, nearly 1400 farmers tripled their basic grains' yields as a result of adopting soil conservation practices. Subsequent follow-up studies indicate that further adaptation and adoption continue (Bunch and Lopez, 1999). Increases in productivity were also observed, as were increases in farmer experimentation, and the exchange of information among farmers.

Of the three cases, one, World Neighbours, was NGO supported; the others were managed by Future Harvest centres. The important actor that is missing here is the national agricultural research organizations (NARO). The NAROs participated in some of the cases to varying degrees. These patterns of institutional involvement reflect the broader inventory results; NAROs are often involved in the NRM projects but not in a leading role. The survey results show that in the 37% of the cases in the inventory of 83 NRM project, Future Harvest Centres had the lead role, in 16% of the cases NGOs had the lead, in 12% of the cases universities were leading, and 9% of the cases were lead by NAROs (Johnson et al., 2000).

Table 1 places the cases within the Lilja and Ashby typology. At the design stage, participation tended to be slightly more consultative, whereas authority was more likely to be shared with farmers in later stages. Where fundamental directions and priorities are set, it appears that control still remained with the researcher, largely

[6] World Neighbours is an international non-governmental organization (http://www.worldneighbors.org)

Table 1
Types of participation used in the three case studies[a]

Stage	Conventional (no farmer participation)	Functional consultative	Empowering		Farmer experimentation
			Collaborative	Collegial	
Design	WN, ICRISAT	CIP	CIP		–
Testing	–	ICRISAT	CIP, WN		–
Diffusion	(ICRISAT)	(CIP)	CIP, WN		CIP, WN ICRISAT

[a] WN = World Neighbours—Honduras, CIP = Centro Internacional de la Papa—Indonesia, and ICRISAT = International Crops Research Institute for the Semi-Arid Tropics—Southern Africa. Parentheses indicate an activity that is planned, but remains to be executed.

reflecting the sectoral nature of R&D funding. Again, these patterns of participation are consistent with what was observed for the full inventory of projects.

Classifying project activities as either testing or diffusion was difficult. As a consequence of participation, planned diffusion now begins in the testing stage, where researchers hope that by involving farmers in trials, both participating and non participating farmers will gain awareness of and access to the technologies. This change may be related to the fact that the information-intensity of NRM-focused practices requires farmers to learn something about how the technologies work.

4. Results[7]

Findings are reported for each of the four types of impacts. We begin with process outcomes and conclude with technology and cost impacts, a logical order given that the former effect the latter.

4.1. Feedback to research—did user participation influence research objectives, priorities, and practices within and beyond the project?

All three projects generated useful feedback to research within and beyond the project. As a direct result of farmer participation in the design stage of the research process, the CIP project shifted its focus from integrated pest management (IPM) to integrated crop management (ICM). The results of participatory rural assessments (PRAs), production surveys, and negotiations with farmer-researchers consistently showed that pest management was not the most important constraint facing sweet-potato producers, and that the project would be more effective by broadening its scope to include not only pest management but also varietal selection, seed and plant health, nutrient management, and economics and marketing. This change had significant implications for project activities at all subsequent stages.

[7] The results summarized here are presented in full in Johnson et al. (2001).

In the World Neighbours and ICRISAT projects, objective and activities were already defined by the time that users were brought in, so there was less scope for making change. Nonetheless, in both cases farmers' input did lead to changes in types of technologies tested, the protocols for testing, and the way the results were evaluated. In the World Neighbours case, adaptations to the technologies tested included changing the recommended slope of some contour ditches and the composition of plants in the contour barriers. Farmer influence also resulted in a shift from collective to individual test plots.

In the ICRISAT case, farmers contributed to the development of new technologies for testing, for example, combining small quantities of organic and inorganic fertilizers. They also identified potentially important aspects of technologies such as weed suppression that researchers had not considered. Some more radical farmer proposals such as incorporating additional crops were not accommodated, however. Farmers who opted to make these changes were excluded from the official trials, though in some cases they continued to receive informal support from field staff for their experiments.

In the ICRISAT case, farmers and researchers differed on how they ranked technologies and on their criteria for ranking. Researchers initially ranked groundnut-pigeon pea and maize-*Tephrosia* intercrops as the best for farmers because of their high grain yields. Baby-trial farmers, however, ranked maize-pigeon pea intercrop as the best because of the grain-legume mix and the lower labour requirements. Economic analysis of baby trial data (Rusike, 2001) later confirmed the superiority of farmers' choices. According to the baby-trial farmers, the pigeon pea-groundnut rotation was attractive, but only for commercial farmers who had enough land for rotations.

Only the CIP and World Neighbours cases worked on the dissemination activities, though in the case of World Neighbours the testing and dissemination stages were essentially combined. In the CIP project, farmers helped design the farmer field school (FFS) curriculum. Farmer input came in the form of participation in, and evaluation of, pilot field schools. The main contributions from farmers were: (1) greater focus on experimentation skills rather than recommendations, (2) more emphasis on interpersonal dynamics within the field school, and (3) the recommendation that field schools be implemented by the existing FFS agency rather than by the project itself in order to enhance their creditability and appeal to farmers.

Changes in priorities and practices were also observed in individuals and institutions beyond the scope of the specific projects. In the case of CIP, the shift from IPM to ICM that occurred within the project can also be observed in other CIP potato and sweetpotato work in Asia, Latin America, and Africa. The results of the project contributed to a reduction in emphasis on sweetpotato weevil research in Asia, and an increase in sweetpotato breeders' focus on scab disease and starch content. A CIP researcher involved in the project who had not had significant experience doing participatory research went on to lead a project on participatory research in another Future Harvest Centre. Another was named leader of a newly formed centre working group on participatory methods. The Indonesian NGO involved in the project has adopted more participatory approaches to problem identification and now incorporates farmer experimentation in all its activities. No evidence was found of substantive changes in the participating national agricultural research program.

The participatory testing model developed and used in the ICRISAT case has been widely disseminated (Snapp, 1999) and adopted by researchers from other Future Harvest Centres (CIMMYT, 2000; Suwarno et al., 2002; de Meyer and Banziger, year unknown). Within ICRISAT, a multi-institutional project involving Future Harvest Centres, NGOs, and NAROs to assess women's participation in soil fertility work was developed as a follow up to the initial activities. Unfortunately, extensive turnover of staff in national institutions limited the extent to which change occurred there.

The success of the World Neighbours project has been widely publicized, and has had a great deal of influence in the fields of sustainable agriculture and community and rural development. A guest log still maintained by one of the farmers who participated in the project is testimony to the broad and sustained interest in the project on the part of researchers and development practitioners around the world. Most of the impact has been methodological, especially among social scientists and practitioners in the areas of participatory methods and farmer-to-farmer dissemination. The agronomic innovations in the project seemed to have had little impact on research on soil conservation technologies.

In summary, within the projects, farmer input led to change at every stage in which it was incorporated. As expected, the scope for change was greater the earlier farmers were incorporated. Empowering participation was associated with more changes within specific projects than functional participation, and in no case was farmer participation redundant, meaning that the same decisions would have been made by researchers alone. In the CIP case, however, we saw that functional participation (PRA and farmer-managed surveys) and empowering participation (farmer researchers) reached the same basic conclusions at the design stage. In the case of impacts beyond the project, no clear relationships emerged between type of participation, stage and impact. This is consistent with the fact that these impacts are further removed from the projects and therefore subject to more outside influences. NARO's tended to be less influenced by lessons of participation than international centres or NGOs.

4.2. Impact on human and social capital among participants: did participation strengthen local experimentation capacity and/or broaden problem solving skills?

Participation was hypothesized to affect human and social capital in two ways, first and most directly via enhanced capacity to experiment with new agricultural practices. Beyond experimentation, participation could strengthen participant's general analytical abilities, problem-solving skills, and ability to initiate and sustain innovation with external facilitation. It was assumed that these types of benefits would only occur in empowering participation, and the evidence from these cases support that hypothesis.

Evidence of enhanced experimentation skills was found in the CIP and World Neighbours cases. In the World Neighbours case, farmer capacity to experiment with and adapt technologies is credited with being the key to its success. According to farmers surveyed in 2001, 45% of farmers experiment. Of these, 21% said they learned to experiment from World Neighbours, a large proportion considering that the project occurred 15 years ago and many current farmers were not old enough to have participated.

In the CIP case, we found evidence of enhanced experimentation capacity among the eight farmers who worked intensively with researchers to develop and test ICM technologies. The farmers themselves, project staff and key informants in their communities concurred that these men had changed significantly as a result of their participation, and were now viewed as innovators and expert farmers. Project documents also reveal how their skills and capacity increased over the course of the project. As further evidence, when we arrived unexpectedly in the house of one former farmer-researcher we observed the project's data collection template hanging on his wall, partially filled in with data from his current crop. It is important to note here that these farmers were invited to participate by project staff on the basis of their skills, interest, and ability to work well with the rest of the team. These men were not considered innovators at the time of their selection—one recent secondary school graduate was not even farming—but they clearly were seen as having potential.

While farmer-researchers did enhance their experimentation skills, farmers who participated in the ICM–FFS ultimately produced by the research project did not. A survey found no significant difference in incidence of experimentation between FFS attendees and non-attendees (van der Fliert et al., 2001: 337–338). In some cases, certain farmer field school participants did continue to experiment jointly after the class, but this was not widespread or systematic. The intensive and prolonged interaction with project staff, a major difference between the experience of the farmer researchers who developed technologies for and designed the curriculum of the FFS and the farmers who attended it, was clearly important for building experimentation skills.

Impact of the project on human and social capacity beyond agricultural experimentation also centred on the farmer researchers. These eight researchers formed strong bonds and continued to maintain them after the project ended. Their roles in their communities also changed, compared with other farmers and officials such as extension agents. The skills they learned helped them to advise their neighbours and to help them negotiate better prices with traders. The farmer-researchers shared the benefits of their increased knowledge and skills with the rest of the community. However, it would be incorrect to interpret this as an impact on community information sharing. Rather, it appears to be a consequence of existing modes of social interaction in the Javan communities. In the ICRISAT and World Neighbours cases, for example, participating farmers did not initially share information about the trials with other farmers and had to be instructed to do so as a condition of participation.

Evidence of enhanced farmer experimentation in the ICRISAT case is mixed. In Chisepo, the site for this study's fieldwork, farmers who managed baby trials were able to describe the trial protocols and the data that were collected and analyzed, but could not explain the logic of the trial design nor articulate concepts such as controls or replications. None said they would continue doing systematic experiments after the trials were finished. Subsequent impact assessment by ICRISAT staff found that in other communities, where implementation of the Mother–Baby methodology was more flexible and where farmers received "training for transformation" parallel to the Mother–Baby trial activities, impact on local experimentation appears to have been stronger (Heinrich et al., 2001; Rusike et al., 2001).

The World Neighbours case was where we found the greatest evidence of increased individual and social capacity, which is consistent with its development focus. As part of the project's methodology, a select group of farmers was trained to work as farmer-promoters within the project. About 50 such farmers were trained, many of whom went on to work with other agricultural and development projects in Honduras and abroad. Some have returned to the region and continue to work with both local and external organizations in agricultural and NRM issues.

To examine impacts at the level of the broader community level, we used data from a 1995 assessment by Escuela Agricola Panamericana (EAP, also known as Zamorano) of all 27 communities in the Yeguare watershed, which includes Guinope where World Neighbours worked. Each community was ranked using 13 criteria such as accessibility, university interest in the zone, capacity of the local people, and community organizational capacity. According to the results, the eight World Neighbours communities in the watershed were significantly less accessible than other communities in the watershed, yet they had higher levels of both human capacity and organization/institutional capacity. In the case of human capacity, the difference is statistically significant ($P = 0.005$) (EAP, 1995). During fieldwork for this study conducted in 2001, many farmers credited the World Neighbours project with increasing community activities and solidarity, though responses differed by gender and by community. We have no data on these variables pre-project, but project staff insist that the communities were no different from their neighbours when the project began.

In summary, human capital impacts were observed where there were high levels of training and high levels of interaction with researchers. In these projects, this generally occurred where empowering participation was used at the testing stage. The fact that the repeated interaction with staff in technical activities seems to be a key determinant of skill-building suggests that such impacts would not be likely at the design stage even with empowering participation. It is important to note that in both cases where human capital impacts were observed, participants were selected on the basis of their actual or potential ability to contribute to the project, which means they were not representative of the general population.

There is little evidence of strengthened social capacity in any of the three projects, which is probably due to the fact that the plot-level nature of the technologies did not require a collective action focus. The extent to which communities benefited from the human capacity development among a small number of direct participants in the projects depended on local conventions regarding social interaction and information sharing.

4.3. Technology impacts: did participation affect the adoption or economic impact of the technologies developed by the projects?

Participation is hypothesized to affect adoption and economic impact of technologies by improving relevance and appropriateness of the technology to the potential beneficiaries, and thereby enlarging the pool of potential adopters. Participation is also hypothesized to shorten adoption lags, but we were unable to evaluate this impact in these case studies.[8]

The results presented in the previous sections on how farmer participation influenced the priorities and activities of projects are certainly consistent with the expected impacts on adoption. The impact of the CIP case, measured in terms of impacts on the farmers who participated in the pilot implementation of the ICM-FFS, was documented through interviews with participants before and after the FFS and through producer surveys of both participants and non-participants. Data from the producer survey showed that both FFS attendance and adoption of ICM components had significant positive impact on income from sweetpotato production (van de Fliert et al., 2001). While panel data were not available, analysis of baseline data found no significant differences among producers who would go on to participate and those who would not, so the positive impact on income appears to be attributed to participation in FFS. Post-FFS survey data also show significant differences between the practices of farmers who attended the FFS and farmers who did not, especially in the adoption of varietal selection and nutrient management, two topics that were included in the ICM–FFS as a result of farmer input.

To assess the contribution of farmer input to the impact of the ICM–FFS, we also analyzed data on what aspects of the FFS the participants most frequently recommended to other farmers. Their responses suggest that the ICM rather than IPM components were the most important. Seed health was the most common topic mentioned (26%), followed by nutrient management (23%). Pest- and disease-related topics were mentioned by fewer than 15% of ICM attendees, and only 6% of attendees reported mentioning pest- and disease-related aspects as most important. This confirms that had the project focused only on pest and disease issues, it would have been less relevant to farmers' needs.

The investment that World Neighbours made in building farmer capacity and adapting technologies to local circumstances appears to have paid off in terms of capacity to innovate rather than adoption, per se. According to Sherwood and Larrea (2001), 1500 farmers introduced soil conservation practices as a result of the project, about 34% of the total number of farmers in the municipality, but these were different practices from those originally promoted by World Neighbours (Hellin and

[8] However, some documented empirical evidence about the impact of participatory research on adoption lag can be found in participatory plant breeding projects. An analysis of the participatory barley breeding work at the International Centre for Agricultural Research in Dry Areas (ICARDA) shows that the structure of participatory plant breeding itself has potential to reduce the research and development lag by three years, and hence corresponds to an earlier flow of research benefits, and ultimately higher returns to research investment (Lilja and Aw-Hassan, 2002).

Larrea, 1998). The practices originally introduced and for which farmers received training, by and large, dropped out of the portfolio of conservation practices used locally, but farmers experimented with and introduced novel ones, demonstrating a capacity to innovate beyond the adoption of recommended practices. Data collected in 2001 as part of this study found that 44% of farmers were using conservation practices as a result of the project. This contrasts sharply with the generally very low levels of adoption of soil conservation practices in Central America and around the world. Benefits are primarily realized through increased crop yields. By 1998, nearly 1000 farmers had achieved yields of over seven times their traditional levels, and nearly 1400 had at least tripled yields. Although these numbers reflect agronomic rather than economic gains, and in some cases refer only to what farmers achieved on their test plots, they nonetheless demonstrate that a significant number of farmers were working with the technologies and achieving good results. Estimated cost per hectare under conservation practices in World Neighbours was US$208. Other similar projects in the region that didn't use this intensive participatory methodology had costs of US$6414 and US$2000 per hectare (Kaimowitz, cited in Dvorak, 1996).

While the ICRISAT project has yet to achieve significant adoption, an awareness/adoptability study carried out in 2001 showed that farmers, especially those who were not participants in the Mother–Baby trials, were more likely to visit the baby trials than the mother trial. This suggests that the inclusion of baby trials may have increased the number of farmers who were exposed to the technologies compared with a conventional on-farm trial.

In summary, farmer input appears to have been important in improving the relevance and appropriateness of the technologies, and therefore enhancing their actual or potential impact. Where technologies are complex and adaptation by users is likely, building farmer capacity is important to achieving sustained innovation. This suggests that empowering rather than functional participation at the testing stage will make a bigger contribution to impact-oriented R&D projects working with these types of technologies.

4.4. Costs of research: what difference did participation make to the cost of the project

A common excuse for not using participatory methods is that they add to the cost of a project. There is some evidence to support this. In the inventory of participatory NRM projects, 46 percent said that participation increased project costs while 33 said they were reduced and 20 said they were unaffected (Johnson et al., 2000). While this study did not look at sources of cost increases, we could hypothesize that they would arise because of time and travel costs involved in consultations and negotiation with farmers. Cost reduction, from the point of view of the research institution, would be realized if tasks that would have been done by staff were passed to farmers and done off station. Farmers need to get a return on the time they invest in participation, but this return can be realized in several different forms[9] and

[9] How farmers are compensated for participation clearly affects who is willing and able to participate, and should therefore be considered carefully when deciding how to select participants.

is usually less costly to the research budget than if the work were done by salaried staff of research organizations.

Evidence from these three cases generally supports the conclusion that participation increases research costs in whatever stage it is used when researchers and farmers are learning to use new methods but the costs are insignificant in the context of overall research expenditures. In the CIP project, most cost increases seem to have been incurred in the design stage, when farmer input was sought via surveys and PRA interviews as well as by interactions with farmer-researchers. In this case, the consultative on-farm research methodology—the multi season collection of production data by farmers involving multiple visits—was almost certainly more costly than the empowering participation, though both may have been necessary to convince project staff to change priorities. This highlights the difficulties of costing participatory approaches and comparing them with conventional research when researchers and farmers are still learning how to use new methods or are assessing which of several alternative approaches to use.

At the testing stage, farmer participation was in the form of management of field trials, and the only cost items that would been avoided in a conventional project were the series of eight workshops at which farmer-researchers and other project staff met to design field trials, evaluate results, and plan dissemination. Workshop costs were low, on average less than US$100 per workshop. Because farmers, rather than project staff, did much of the fieldwork in the participatory approach, research costs were reduced even when farmers were compensated for their time, not itself a recommended participatory research practice. As noted earlier, the CIP project changed priorities as a result of participation, but it should also be pointed out that project was completed on time and within budget which shows that sharing decisions with farmers does not have to result in delays.

Like the CIP project, the World Neighbours project worked intensively with farmers in the testing of new technologies. No subsidies were provided to farmers for their participation in this development-oriented project. Staff commitment to a community was very significant, however; a staff member lived in the community for the duration of the project. This is reflected in the fact that the majority of project costs—75% in the last year—were for salaries. The intensive and long-term presence maintained by World Neighbours staff in a community to support participatory learning was clearly more costly than a typical extension project if numbers of communities or farmers visited per staff member are compared. However, it was inexpensive if assessed in terms of cost effectiveness, as shown in the cost/benefit figures cited in the previous section.

Comparing the amount of time spent on the ICRISAT Mother–Baby trials with conventional on-farm trials in the region is difficult because there is no "typical" experience. Some researchers never visit their field sites at all, while others maintain a frequent presence there. The ICRISAT staff found that the better supported baby trials produced more reliable data than those that received fewer or less timely visits from field staff, which suggests that looking for savings here may not be cost effective.

Where ICRISAT scientists noted a significant increase in project costs due to user participation was in building capacity of researchers and field staff in participatory methods. Cost increases were also associated with analyzing data collected from farmers, mainly because this required statistical techniques not used for analysis of conventional agronomic data. While significant, these costs should be treated differently because they are essentially start-up costs incurred because staff were not familiar with participatory methods. They would not be incurred again in subsequent projects.

In summary, in these cases it appears that some research costs decreased (or were transferred to farmers) when participation meant that farmers took over on-farm research activities previously done by research staff. Other costs increased slightly because of participation, regardless of the stage in the process at which farmer involvement occurs. Some increases were related to the extra time and effort invested by researchers and farmers who were learning to use a new approach. One-time cost of training project staff in use of participatory methods represent start up costs, and in comparing costs of participatory and non-participatory costs, they should be treated differently from the operating costs of implementing a participatory approach when those involved are experienced. Results from another participatory study also show that participatory research often only affects the operational costs, and has less impact on personnel and overhead costs. Operational costs are often, at least in the Future Harvest Centres, a relatively small portion of the total research budget (Lilja and Aw-Hassan, 2002).

5. Conclusions

Multiple data sources and methods were used to assess the impact of user participation on researcher's impacts and costs in three case studies, CIP's development of an Integrated Crop Management Farmer Field School for sweetpotato in Java, ICRISAT's assessment of legume-based soil fertility technologies in Malawi, and World Neighbours' participatory promotion of soil conservation practices in Honduras. Four types of impacts were assessed: feed back to research; human and social capital impacts on participating farmers and communities; adoption and economic impacts of project technologies, and costs of research.

In all three cases, user participation at all stages of the research process provided useful feedback to researchers that improved the relevance and appropriateness of the technologies and contributed to actual or potential impact of the research. In general, the earlier users were incorporated into the process the more impact their input had on project appropriateness. Empowering participation was associated with important changes in technology design that fed into increased adoption.

Empowering participation was essential for strengthening the human capital of participants. Training and intensive interaction with project researchers were key to strengthening experimentation and innovation skills among participants. This has important implications for the development and dissemination of complex technologies such as natural resource management: since experimentation and adaptation are crucial to adoption and impact, and since the capacity to experiment only comes through empowering participation, impact-oriented NRM projects should be very wary of using functional participation. It could increase costs and contribute little to on the ground impact.

In some respects research costs decreased and in others they increased slightly because of user participation in the research. Costs of participation for research rose when start up costs were incurred because project staff needed training in participatory methods.

Finally, the limited participation of and impact on national agricultural research organizations that was observed in these projects is worrying given their potential comparative advantage in on-farm adaptive research and extension. It appears that at least part of the problem is structural—high staff turnover and incompatible incentives, e.g. no money for fuel to go to the field. Resistance to change is also a factor, and some studies have shown how this can be overcome when the institutionalization of participatory research methods becomes important to strategic decision makers in national systems (Menter, 2001; Lilja and Erenstein, 2002). More studies such as this that document the potential benefits and costs of participation will be useful. Influencing research policy and the motivation of researchers to incorporate participatory research approaches still requires convincing evidence that research effectiveness depends on giving intended beneficiaries a say in determining research agendas and that if a serious investment is made in developing capacity to use them, participatory approaches can provide a mechanism for holding down research costs.

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Any mistakes or omissions that follow are the fault of the authors. This is particularly relevant in this case as we had to condense the vast amount of information received from the case studies. It inevitably means that we may have simplified some aspects of the projects represented here. We hope that the readers who are interested in learning more about the individual projects represented in this paper will contact projects directly for further information or request a copy of the complete report on the case studies presented here (Johnson et al., 2001).

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