Participatory Technology Development and Transfer: The Key to Soil Fertility and Water Management Technology Adoption in Zimbabwe

Report No. 2

ICRISAT

INTERNATIONAL CROPS RESEARCH INSTITUTE FOR THE SEMI-ARID TROPICS

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2008

Acknowledgements

The authors would like to thank a number of individuals and organizations who were instrumental in collecting data and contributing to this document. Thanks are due to all farmers who participated in the household surveys for providing information which formed the basis of this study. We also want to thank the extension staff from AGRITEX who facilitated the data collection process as well as field officers from various NGOs – CARE, OXFAM, World Vision, CADEC, ORAP, and ZWP. This study was supported by a research grant from the IDRC and we would like to register our gratitude for the financial support. Finally, we would like to thank Team ICRISAT for technical, financial and administrative support especially the Agro-ecosystems team at ICRISAT-Bulawayo.

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1. Introduction and Background

There are few non-farm engines of growth and poverty alleviation in most sub-Saharan African (SSA) countries. This implies that smallholder agriculture is likely to remain the major source of rural growth and livelihood improvement for a long time to come, as well as the center of individual nation's economic growth (World Bank 1997). Many sources continue to establish that the persisting impoverishment of rural SSA is due to declining land productivity under an increasing population that uses low input farming methods (IFAD 1994; World Bank 1996; Woodhouse 2002). In addition, farmers have invested little in soil fertility management and crop yield despite decades of research (Ryan and Spencer 2001; Mapfumo and Giller 2001; Scoones 2001). The consequence of this is widespread accelerated erosion, degradation of soils, and deforestation (Hoffman and Ashwell 2001). As the natural resource base is degraded, it is becoming increasingly difficult for resource-poor farmers to maintain their livelihoods and quality of life.

Researchers, often in collaboration with farmers, have dedicated considerable time and resources over the past decade to developing farming technologies and natural resource management (NRM) practices. These are often aimed at breaking the vicious circle of poverty by facilitating intensification and thereby increasing agricultural productivity, food security and rural incomes across SSA. However, several years of NRM research have proved disappointing in halting degradation in stressed environments and fragile ecosystems where poverty is increasing (Ashby 2003). Critics are saying that the research establishment is incapable of addressing the decline of rural society, the needs of poor rural populations in fragile environments, and the deepening crises in the depletion and degradation of natural resources; some argue that resource management science is fundamentally on the wrong track (Ashby 2001; Campbell 1998; Chambers 1997).

Most of the growth in food production during the past three decades has resulted from the adoption of productivity-boosting technologies in areas of high agricultural potential, particularly those with relatively high and reliable rainfall or fields equipped with irrigation. A major challenge in the coming decades will be to generate technologies that contribute to increases in agricultural production and improvements in livelihoods in lower potential areas. Although many promising technologies have been developed and made available, the field application of these is limited (Knox and Meinzen-Dick 1999).

The adoption of technologies that would improve productivity is too often gradual and incomplete. There is no simple answer to the question of why many African farmers do not adopt or adapt the seemingly superior technologies already available. Economic factors, learning effects, geographical proximity and the household characteristics of farmers are all related to the dynamics of technology adoption. It has become apparent that there is a greater need to consult with farmers not only about the questions that they wish resolved (Ashby 1990; van Veldhiuzen et al. 1997), but also about the manner in which the issues preventing access to various solutions, including technologies, could be resolved (Heinrich 1992; Ashby and Sperling 1995; Röling and Wagemakers 1998). The process must be farmer centered, fully involving the intended beneficiaries from the early stages of problem identification.

Except in regions where the Green Revolution has taken place, there are few opportunities for widespread dissemination of new agricultural technologies in the form of predetermined packages. Each farm differs in terms of its resource endowment, especially in the relation between land and labor resources, degree of access to input and output markets, and vulnerability to risk. Each household also differs in terms of needs and objectives, particularly in the extent to which farmers see production as contributing mainly to family food security as opposed to cash income. The need, therefore, is for participatory approaches to research and development that can engage farmers in diagnosing problems and in identifying possible solutions adapted to their particular circumstances. These approaches can also help to inform researchers of priority areas for investigation and enable them to better understand farmers' viewpoints and perceptions, thereby increasing the relevance of research. Table 1 presents a historical look at the progress of participatory technology development in Zimbabwe.

Since 1997, the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) has implemented farmer participatory research (FPR) programs in Malawi and Zimbabwe to test a range of researcher-derived best-bet soil fertility management technologies and evaluate the impact of alternative FPR approaches (Rusike et al. 2001). The objective of this Will Women program was to identify practical and sustainable soil fertility improvement options for smallholder farmers through on-farm, farmer participatory evaluation of technologies (primarily research-defined 'best bet' technology options (Snapp et al. 2002)). Monitoring farmer adaptation of technology options and systematically identifying and re-introducing their modification into the wider research agenda proved especially difficult. Adoption of these technologies has been poor in the past, but innovative approaches such as farmer field schools (FFS) and participatory extension are proving successful in enhancing adoption of integrated soil, water and crop management practices (Rusike et al. 2004).

Table 1. Chronology of participatory technology development and dissemination in Zimbabwe

Period	Type	Key promoters	Main message	Remarks
1980s–1990s	Train and visit linked to Master Farmer	World Bank through AGRITEX	Encourages farmer-to-extension agent interaction, the first week consisting of training and the second week involving farm visits.	Provides irrelevant or impractical messages. Too bureaucratic and inflexible. Too expensive and does not empower farmers (Rukuni 1996).
1990s	Participatory agricultural extension	ITDG, GTZ, AGRITEX	Involves the use of training-for-transformation and look-and-learn-visits (Hagmann et al. 1996)	Exclusive rather than inclusive of the poor. High level of support required for extension (Chipanera et al. 2001).
2000–2003	Farmer Field Schools	UZ, AREX, NGOs	Use of groups to develop new interventions. Involves evaluation and application of improved technology options within the farmer's community.	Alternative pathway for top down approaches and recommended to be promoted (Rusike et al. 2004). High cost in time.
2003 to date	Relief and recovery ICRISAT capacity building program	DFID, ECHO, FAO, NGOs	Builds upon seed and fertilizer relief programs	The vulnerable groups have a chance to receive extension support (Twomlow and Hove 2006).

The FFS program was initiated to build farmer capacity for continuing experimentation and scaling out effective technology options. The project strengthened community structures and linked farmer groups to research and extension committees.

ICRISAT has conducted extensive work in developing soil, water, and crop management technologies as well as mineral and organic nitrogen management strategies to optimize water-use efficiency in drought-prone environments (Twomlow et al. 2003). To complement the field work, a linking logics workshop was conducted in Bulawayo, Zimbabwe, to explore the linkages between FPR approaches and computer-based simulation modeling (Dimes 2001). The workshop was aimed at increasing productivity at smallholder level by making use of crop simulation models. The influence of this early work conducted by ICRISAT and partners subsequently led to the promotion of microdosing (MD) and Conservation Agriculture (CA) (Box 1).

Box 1. Conservation agriculture and microdosing defined

Conservation Agriculture (CA) is "a way of farming that conserves, improves and makes more efficient use of natural resources through integrated management of the available resources combined with external inputs" (FAO 2001). CA is a detailed and comprehensive technology using basin tillage and it consists of many technological components which results in major changes in the farming system.

The central component of the basin tillage package is the planting basin. Seeds are sown not along furrows, but in small basins or simple pits. These basins can be dug with hand hoes without having to plow the field which is important given that the majority of smallholder farmers in southern Africa struggle to cultivate their fields in a timely manner due to a lack of draft animals (Twomlow and Hove 2006.)

Microdosing (MD) is a precision application of small amounts of fertilizer. MD is aimed at improving fertilizer use on farmer's practice without any major adjustments to the farming system. The rate of fertilizer application is usually one coke bottle cap per three plants at the '5–6 leaf' stage when the technique is applied under farmer practice but when applied under CA, the rate is one coke bottle cap per basin.

In 2003, ICRISAT, with multiple partners, was involved in relief programs that were designed to stabilize food security and protect the livelihoods of the poor and vulnerable households, particularly those affected by HIV/AIDS. A total of 1200 experiential demonstrations were established to promote MD and support the distribution of 4000 tons of Ammonium Nitrate (AN) fertilizer. In 2004, the birth of the Protracted Relief Programme (PRP) resulted in the scaling up of MD as well as the introduction and promotion of CA. Both technologies can be implemented at low cost and significantly contribute to raising productivity. The number of farmers hosting trials through PRP has been on the increase since 2004. These trials consist of a paired design where farmers evaluate the differences in performance of either CA or MD with the traditional farmer practice. Farmers keep records and all quantitative data for both plots on behalf of ICRISAT researchers. The farmers hosting these trials provided a sample of farmers to be interviewed for this study to assess the levels of participation in the process and approach

2. Review of Literature

2.1. Farmer participatory research

'Participation' and 'participatory' have recently become such fashionable terms that any kind of activity involving a group of people is often called 'participatory'. This 'participatory' labelling embraces a multitude of meanings, posing a serious threat to the concept and practice of 'participatory research' (Ashby 1997). Farmer participatory research has been defined as "the collaboration of farmers and scientist in agricultural research and development "(Bentley 1994). Freeman (2001) alludes to the fact that FPR can help improve the effectiveness of technology development, raise adoption rates, and increase the payoff to agricultural research

An introduction of an International Development Research Centre (IDRC) report described 'participatory research' as "a mode of research which is attracting growing attention from agencies of development assistance but which remains exploratory in many scientific domains" (IDRC Working Group 1988). In a similar report of 1995, it was concluded that "while participatory research has (now) become more widespread, considerable confusion abounds concerning terminology, types of participatory research, theoretical underpinnings and operational practice" (Found 1995). Participatory approaches fundamentally challenged the conventions of classic approaches that underpin most applied agricultural research and the way in which public-sector agricultural research serves resource-poor farmers in stressful environments.

The fact that smallholder farmers conduct experiments on their own is well documented (Johnson 1972; Richards 1986) and has become a pillar of farmer participatory research (Ashby et al. 1995). Farmer's experiments are important in promoting knowledge and evaluation of new unproven technologies without jeopardizing farmers' livelihoods or scarce resources. These experiments are a farmer's basis for generating and adapting new technological options that fit his/her specific needs and conditions. Keller (1992) pointed out that the purpose of technology development and transfer is to improve standards of living by generating opportunities for people to improve their livelihoods. However, this has not been the case in the context of persistent poverty in Africa. In fact, smallholder farmers have failed to capture the full benefits of adopting high-yielding varieties because they have not adopted the complementary improved crop management practices (Rusike et al. 2001). With improved varieties farmers can capture the benefits by simply planting new seed whereas with soil fertility technologies, farmers need additional knowledge and experience regarding what product to use, and when and how to apply it. These technologies are risky and uncertain, increasing the possibility of implementation failure and reducing adoption rates. Limited stakeholder involvement ranks high among the causes of the failure of technology to improve the lives of the majority of the poor in the developing world. The involvement of farmers in every stage of technology development can stimulate the adoption of intensive and low-cost crop management technologies, greatly increasing yields (Pretty 1995).

Farmer participation in agricultural research is more than talking to six farmers or putting ten experiments in the field. Bellon (2001) defines farmer participation as a systematic dialogue between farmers and scientists to solve problems related to agriculture and ultimately increase the impact of agricultural research. It incorporates farmer-to-farmer extension and methods to facilitate the sharing of innovations among a broader group of stakeholders including field days, across visits, extension messages, and replication in other locations. It also includes such activities as research, supply, and maintenance of inputs as well as establishment of a physical, commercial, and educational infrastructure (Haverkrot et al. 1988). There is need to highlight the significant difference between the research and implementation (ie, application or adoption) phases of development. Traditional research collects results, typically for several seasons, before data are analyzed, incorporated into reports, and then 'released'. These are (ideally) taken up by (separate) extension services and translated into extension messages, which are then disseminated. In FPR the implementation of research findings and the related technical and social changes in the rural areas, is integral to, rather than separate from, the research process.

Bentley (1994) has argued that while FPR approaches can increase participation among farmers, it has not brought about impact as a research methodology. Research from Africa supports this argument by showing that less than 15% of "experiments led by farmers" resulted in the creation of new knowledge or the development of new technologies that were not already in existence elsewhere (Sumberg and Okali 1997). It was then concluded that farmer experiments are in fact more "complementary" than "synergistic" to formal agricultural research efforts, and that farmer experiments are more closely linked to agricultural extension activities rather than agricultural research accomplishments.

2.2. Different perspectives to participation

Ashby and Sperling (1997) explained that the usefulness of the participatory concept can only be assessed if there was more clarity on what the goals of participation are, the forms participation might take, and the results of a participatory approach versus non-participatory approaches. It is necessary to scrutinize and test various approaches and building blocks of participatory research with a critical eye. The development of any particular participatory strategy is best guided by understanding the options embraced by the participation rubric and by linking these options with empirical results.

Participatory approaches follow the paradigm that scientists do not deliver solutions, but instead help farmers develop them. In participatory research farmers become the agents rather than the objects of research. This implies that farmers are placed in a position where they can express their own priorities for future activities and choose the innovations to be tested while the scientist helps with the analysis and monitors the innovation process. This allows farmers to opt for 'second and third best' solutions, which may better fit their labor and capital constraints, instead of 'best practices' or 'technical optimum solutions' which are often favored by scientists regardless of farmers' resource endowment and risk management strategies.

A core characteristic of participatory research approaches is the process of interaction between local and external actors to 'co-create' innovators. Several authors have attempted to define different types of participation (Biggs 1989; Lilja and Ashby (2000); Pretty 1994). Biggs (1989) describe 'functional participation' as a scientist–farmer interaction aimed to increase client orientation and higher technology adoption by farmers. The interaction is classified according to the varying degrees of involvement in and control over decision making in the relationship. The classification is contractual, consultative, collaborative and collegiate modes of interaction as shown in Figure 1. The key aspect in the classification is the value of 'ownership' – who is participating in whose process? At either extreme, farmers might participate in scientists' research, or researchers participate in a locally-owned innovation process.

Three prototypical approaches to innovation development are also used as a framework to analyze participatory approaches namely transfer of technology (TOT), farmer first, and participatory learning and action research. In practice, precise boundaries cannot be drawn between them because they constitute prototypes on a continuum rather than clear-cut procedures (Figure 1).

Participatory technology development in the rural context has typically involved farmers and technicians jointly evaluating technology options in terms of their fit within the local farming and food system. There are different

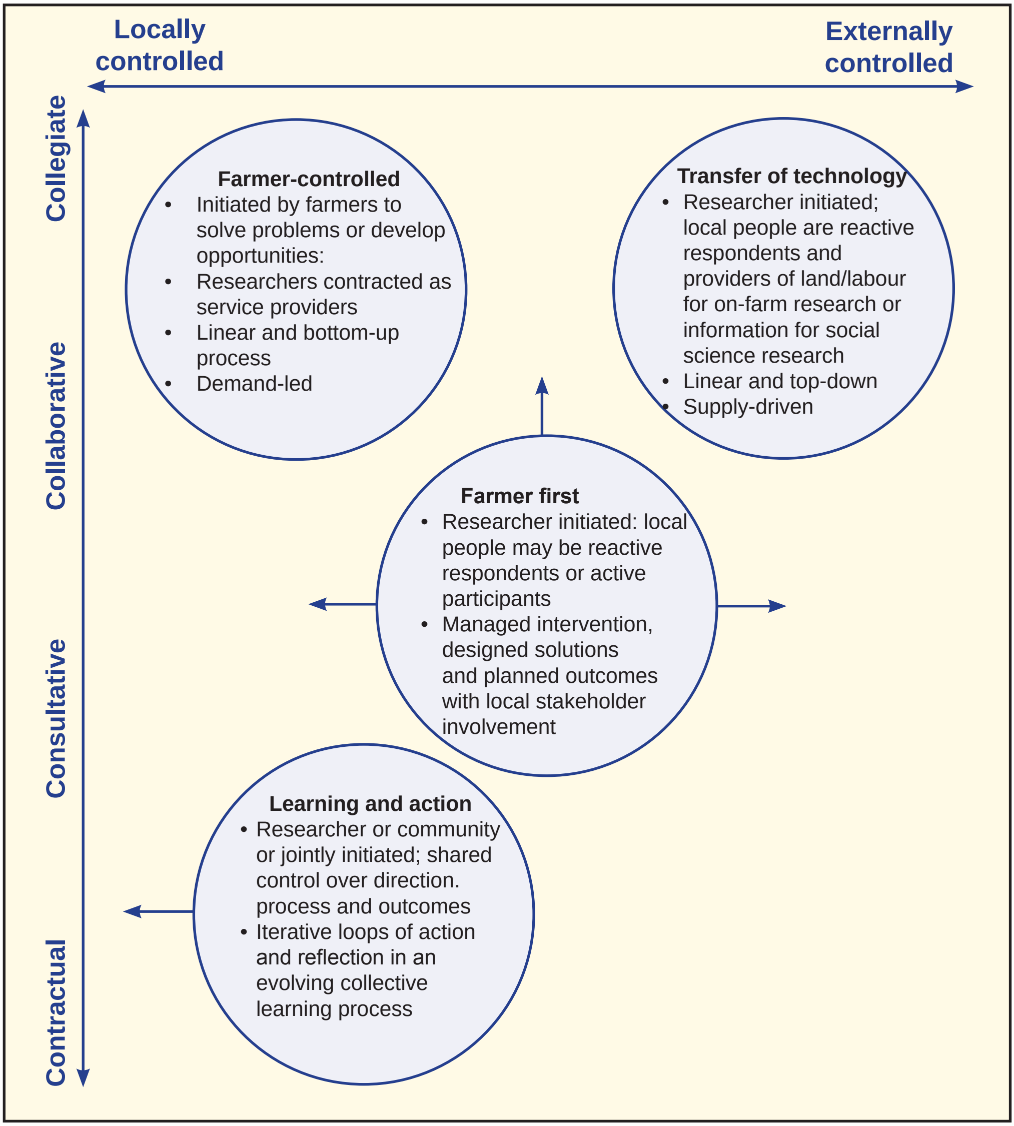

Figure 1. Examples of four 'prototypical' approaches to innovation development

Source: Adapted from Probst et al. (2000)

reasons for why agencies now accept that they need to consult more closely with their target beneficiaries. The need to improve the efficiency of research requires that there is systematic farmer input so as to develop productive technologies or develop technologies faster or with fewer failures. McAllister and Vernooy (1999) state that "there is no right or wrong amount of participation," neither is there any single "best type," nor "best place" on the research spectrum. The challenge is for researchers to consciously navigate the research spectrum in order to maximize the effectiveness and positive contribution of their research to technology development.

2.3 Growing need for participatory approaches in agricultural technology development

The TOT model (Figure 2) is a one-way process where technologies developed by scientists are passed on to extension services to be transferred to users. The TOT model seeks to sell (disseminate for adoption) a product (technology) by identifying potential customers (homogeneous groups of farmers) and improving the advertising (social marketing for extension). However, it fails to feed the clients' views that might make the product more relevant back to its research and development department. The main weakness of this model is that it does not involve farmers in identifying the constraints and adapting the research to local conditions.

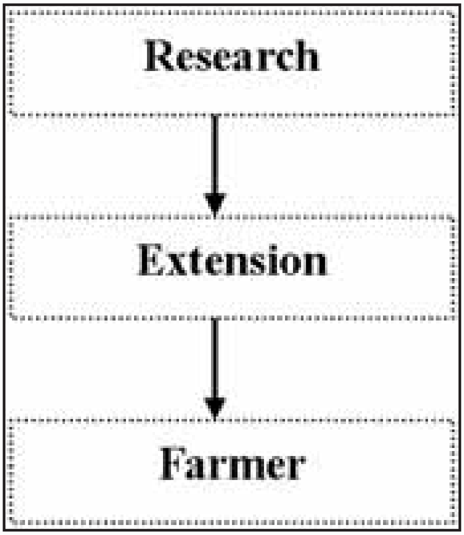

Figure 2. Transfer of technology (TOT)

Source: Adapted from Chambers and Jiggins (1986)

In seeking to address emerging challenges in the post Green Revolution era, the dominant TOT paradigm has proven inadequate for managing more complex second generation issues. These challenges include: diverse biophysical environments, multiple livelihood goals, rapid changes in local and global economies, expanded range of stakeholders over agriculture and natural resources and drastic declines in resource investment in the formal research and development sector (Gonsalves et al. 2005).

Top-down technology transfer may be cheaper and logistically simpler for some technologies. However, as technologies become more complex and the knowledge gap between the technology developer and technology user becomes wider, farmer- and community-based empowerment, education and human development approaches offer lower transaction and production costs (Rusike et al. 2006). The interest in participatory approaches is linked to the problems of traditional approaches to agricultural research, such as the growing dependency of farmers upon external agro-technologies and agro-technicians, thus reducing confidence in their own ability to manage their resources (Okali et al. 1994). In addition, top-down approaches have reduced farmers into passive end-users of solutions who are not consulted on the application of technologies to local conditions. Participatory approaches enhance the efficiency of agricultural research in delivering more suitable and easily adoptable technologies to achieve sustainable development in smallholder agriculture.

The farmer-back-to-farmer model (Figure 3) including farmer first and last, participatory technology development, and FPR are different models of the approaches known as Farmer First. They are designed to improve two-way communication and farmers become part of the process of generating, testing and evaluating technologies that promote sustainable agricultural production. The main expected outcome of these approaches is the generation and adoption of new, appropriate technologies by small resource-poor farmers to aid in solving production constraints in order to increase farm productivity and income (Selener 1997). Research, thus is client- and problem-oriented. In addition, Rhoades (1984) sees research, extension, and transfer as parallel and ongoing, not sequential, disjointed activities. There is a high degree of farmer participation and integration between on-station and on-farm research in these models.

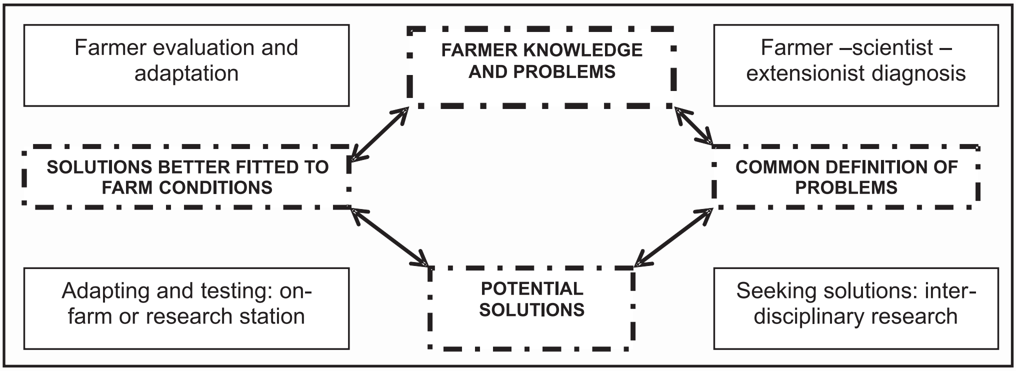

Figure 3. Farmer-back-to farmer technology generation and transfer system

Source: Adapted from Rhoades (1984)

The research (and extension) design allows space for the meaningful participation of local stakeholders, including marginalized groups, and takes into account potentially differentiated perspectives and interests (based on gender, class, age, ethnicity or other aspects). Similarly, farming systems research began as an on-farm methodology to make farming research relevant to farming practice. By involving farmers, advisors, and research in projects, farming systems research offers a pathway of combining scientific and technical expertise with farming practice and local knowledge.

2.4 Participatory research-simulation modelling links

Previous work in both Africa and South America suggest that simulation modeling using a participatory approach can contribute to improved farmer decision making (McCown 2002; Matthews and Stephens 2002). Delve and Probert (2004) agree that there can be synergies between simulation models and participatory research. If the modeling tool is available, then it is not difficult to identify a number of applications and roles for it to enhance participatory research in smallholder farming communities. These might include: filling knowledge or information gaps; assessing climatic risk of technologies; analysis of trade-offs in situations of alternative resource allocation; helping to prioritize research agendas by identifying 'best bet' options and contributing to learning about farm management practice via computer-aided discussions with farmers. In assessing 'new' technologies developed in conjunction with smallholder farmers, neither researcher nor farmers may have the experience to say how they will perform under management conditions beyond that of the trial itself. Complementarities between participatory approaches and computer-based simulation in addressing soil fertility issues at smallholder level have been explored through workshops held at ICRISAT-Bulawayo (Twomlow 2001). Farmers found the simulation outputs are credible and meaningful in a manner that allowed 'virtual' experiential learning take place.

2.5 Shortcomings of participatory approaches

A key criticism of participatory approaches is often that they are very localized and non-replicable. The site and season specificity of the on-farm experiments often limits the spread of the technology (Pound et al. 2002). In drought-prone regions in particular, it is the risk associated with the seasonal rainfall variations that is a key determinant on whether or not a technology is likely to be adopted by farmers, or at least in what form (Marra 2001).

Participatory approaches as a methodology take more time and resources initially. As a scientific tool they pose a challenge because the unsystematic experimentation may lead to false conclusions. The danger of participatory research is that it hides diversity and can present a falsely homogenous view of 'the people' whose views it represents. As many critics have pointed out, participatory methodologies can also be used to obscure differences within target communities, legitimize extractive and exploitative processes of information gathering, impose external agendas, and contain or co-opt potential popular resistance (Asian Development Bank 2004). Ashby and colleagues (2000) also note that participation can be affected by 'participation fatigue', for example where past projects in the area have required input by the community, without generating sufficient benefits. This is, unfortunately, an increasingly widespread phenomenon, which reduces the opportunity for future participation in potentially beneficial initiatives.

3. Objectives and Methodology

3.1 Objectives

The purpose of this study is to capture the effectiveness of participatory processes in agricultural technology promotion undertaken by ICRISAT and partners as it relates to soil fertility and water management technologies for the 2004/05 and 2005/06 seasons. The IDRC-funded project "Strengthening Impacts from Soil Fertility Research" requires an assessment of the participatory nature of project implementation. The participatory nature of the approach used during technology development and transfer could not be observed during promotion and all the reporting was based on interviews with farmers as well as drawing from the work done by ICRISAT on CA and MD in the PRP project. The importance of this study emanates from the direct interaction with the farmer during the period of technology promotion. The PRP project would provide for the middleman approach whereby the technology is promoted through the local extension services (AREX) or various partner non-governmental organizations (NGOs). NGOs and AREX are facilitating the dissemination, testing, and adoption of CA among smallholder farmers in the dry areas of Zimbabwe. ICRISAT as a technical partner concentrates on capacity building efforts by way of providing the extension and NGO staff with knowledge and skills on the management of the technologies as they develop with the participation of the farmers. Undertaking this study provided ICRISAT directly with the relevant feedback from the farmers which would normally be obtained from partner organizations. The inferences made in this paper will be drawn mainly from related literature to support the observations made and justify the conclusions.

The specific objectives of this study are to:

1. evaluate the impact of different participatory approaches and document the challenges faced by farmers in experimenting with soil fertility and water management technologies,
2. describe the major soil fertility and water management technologies adopted by farmers from 2002 to 2006,
3. determine the nature and level of farmer participation during the implementation of technology promotion, and
4. seek ways to improve technology adoption by farmers through farmer feedback.

The study seeks to answer the following research questions:

1. What participatory approaches have ICRISAT and implementing NGOs used in the promotion of soil fertility and water management technologies from 2002 to 2006?
2. Who is teaching farmers about soil fertility and water management technologies?
3. What changes have farmers incorporated into their normal practice as a result of what they have learned?
4. What adaptations have farmers made to the demonstration trials?
5. What are the farmers' suggestions on how development practitioners can improve on program implementation?

3.2. Research area and design

The interviewed farmers were drawn from 10 districts in four provinces of Zimbabwe covering the activities of eight NGOs. The surveyed areas are indicated on the map in Figure 4. A minimum of two wards were covered for each district, targeting those households that held trial plots for either CA or MD. ICRISAT scientific officers who were monitoring the trials provided a list of farmers hosting trials. In almost every district, all farmers in the targeted sample were interviewed. The final sample surveyed had 231 respondents consisting of farmers who experimented with different versions of CA ranging from digging basins, using a ripper tine, digging furrows as well as MD.

3.4. Survey instrument

A survey questionnaire was used to gather information on 'participatory interventions' on a one-on-one basis. The focus of the questionnaire was on what was done and how it was done, totally relying on the farmers' recall and perceptions. The questionnaire went through modifications during its construction with improvements made after training as well as after the pre-test. No adjustments were made on the questionnaire during the implementation of the survey.

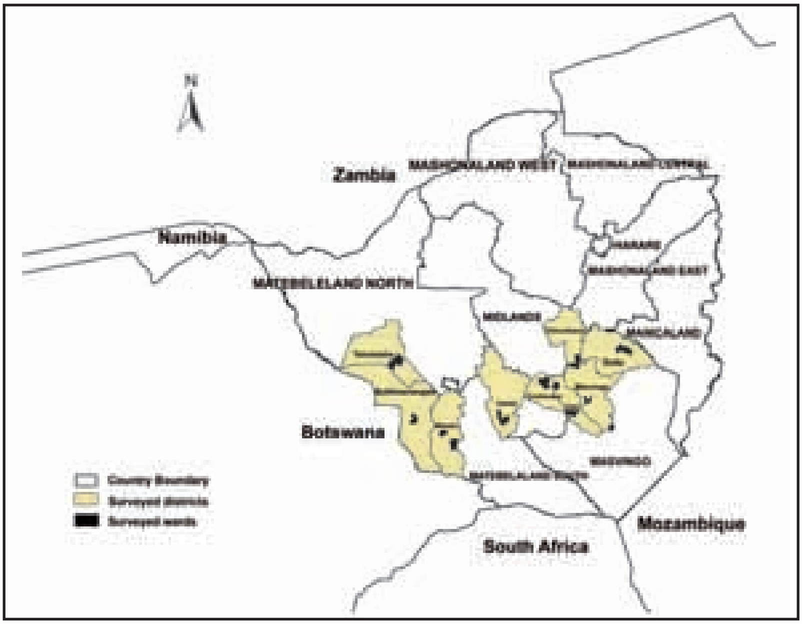

Figure 4. Districts surveyed for participatory technology development in Zimbabwe

Supplementary information was gathered through several approaches in the implementation phase in 2004–2006, which included among others planning workshops, training and field visits, field days, feedback and reflective learning workshops. Personal interviews were also held with ICRISAT officers working on the PRP project in order to gain an appreciation of what was happening on the ground.

All questionnaires were post coded in the field using a code sheet that was adjusted each day. The data were entered and analyzed using SPSS.

4. Findings and Discussions

4.1. Description of the sample farmers

The diversity of the farmers are a result of a number of factors such as gender, location, age, the inception year of technology promotion, and the implementing organization as well as the participatory approach of the implementing NGO. All the sample households had more than 10 years of farming experience on average. Farmers in Bulilima were relatively young in terms of farming experience because they ranged from farmers with 3 years up to 27 years of farming experience. In Gutu the farmers were older and more experienced with the newest farmer having 7 years of experience and the oldest having been farming for 61 years. The sample was dominated

(58%) by male-headed households. However, some NGOs such as Rural Unity Development Organisation (RUDO) in Masvingo, Organisation of Rural Association for Progress (ORAP) in Tsholotsho, and Catholic Development Commission (CADEC) in Mangwe and Bulilima were making a deliberate effort to target widows as a vulnerable group. This resulted in a greater proportion of female-headed households represented in the sample (Table 2). Each household has at least two persons working full time on the fields with Bulilima and Gutu districts having more than three persons providing full-time labor. An average of two persons provide part-time labor to the household farm, though in such areas as Tsholotsho and Bulilima there were more part-time than full-time workers.

Table 2. Characteristics of the respondents

District	Sample size	Proportion of female-headed households (%)	Persons available for farm work (mean)		Farming experience (years)		
			Part time	Full time	Mean	Min	Max
Insiza	24	33.3	3.29	2.15	22.38	2	45
Mangwe	11	81.8	2.27	2.20	20.91	6	39
Matobo	21	42.9	2.33	2.37	24.38	4	51
Bulilima	10	70.0	2.10	3.11	14.40	3	27
Tsholotsho	24	79.2	2.54	2.65	20.54	1	46
Gutu	19	10.5	2.58	3.28	28.32	7	61
Chivi	34	23.5	2.79	2.70	23.91	2	59
Masvingo	31	77.4	2.55	2.77	23.87	4	41
Chirumhanzu	26	23.1	2.19	2.86	19.88	1	38
Zvishavane	29	20.7	2.48	2.68	22.48	3	47
Total	229	42.8	2.56	2.66	22.60	1	61

Source: ICRISAT survey data (2006)

4.2. Soil fertility and water management technologies under study

Soil fertility and water management technologies under study consisted of mainly CA with 84% and MD with 16% of the farmers implementing relevant trials (Table 3). The technologies were introduced as part of donor-funded relief and recovery programs. Farmers would work either in groups or as individuals as designated by the implementing NGO. Discussions with the concerned NGO personnel alluded to the fact that working with women groups was easier. Groups were more prevalent (12%) among farmers practicing CA compared to MD.

Table 3. Trials and implementing NGOs

District	Main NGO	Proportion of farmers implementing trials (%)		Proportion of farmers working in groups (%)
		CA	MD	
Insiza	WV	83.3	16.7	4.6
Mangwe	CADEC	41.7	58.3	0
Matobo	CADEC/WV	85.7	14.3	30.8
Bulilima	CADEC	100.0	0	0
Tsholotsho	ORAP/ CTDT	87.5	12.5	0
Gutu	RUDO	100.0	0	11.4
Chivi	ZWP	88.6	11.4	8.3
Masvingo	CARE/RUDO	100.0	0	36.9
Chirumhanzu	OXFAM	69.2	30.8	0
Zvishavane	OXFAM	72.4	27.6	9.5
Total		84.0	16.0	10.8

Source: ICRISAT survey data (2006)

Farmers who experimented with a ripper tine shared a common implement which required them to work in groups. However, this did not result in efficient use of labor with some farmers in each group not engaging in meaningful work (Figure 5).

Figure 5. Farmers working with a ripper tine which requires sharing a common implement

The PRP intended to encourage 200,000 vulnerable households to practice either CA or MD. During the initial stages all participating farmers would be provided with the inputs and technical support for setting up a trial plot. However, in the subsequent years, the intention was to recruit new farmers and the old ones would source their own inputs. Most of the implementing NGOs used the lead farmer approach whereby a farmer well off in terms of resources was required to train a given number of farmers within the ward. This method encouraged farmers to implement trials as individuals and use the lead farmer as a reference point. According to the survey, 89% (for both CA and MD) of the households employed this method. The 11% who worked as a group used a cluster method whereby a central location was selected as a demonstration plot. This technique is important in ensuring group learning and sharing of labor. This method was effectively implemented by CARE in Masvingo and World Vision in Matobo.

4.3. Shift in soil fertility and water management technologies adopted by farmers

According to the survey findings, there is an increased awareness in terms of soil fertility and water management techniques as a result of training and advice provided by the different institutions. Farmers are now placing more emphasis on those technologies that improve rainwater-use efficiency as compared to previous years (Figure 6). Insights from the study show that almost half of the respondents had made attempts to improve rainwater-use efficiency by adopting some of the practices that have been taught since 1999.

Most farmers reported that they were already practicing techniques related to soil fertility amendment using organic manure comprising cattle manure, dead leaves, and compost. Alternatively, farmers used anthill soil and ashes with very few farmers applying chemical fertilizers for improving soil fertility. Farmers have changed their old practices and taken up the new technology (Box 2), which they consider to be more efficient and economical. However, about 10% of respondents have not adopted any of the techniques they learned in improving soil fertility.

There was a wide variation in terms of soil fertility and water management used across the districts. Areas where more than 20% of the respondents used the technique are marked in Table 4. In Matobo, very few farmers apply cattle manure or chemical fertilizers to improve the soil fertility. In all the districts, the majority of the farmers applied at least two techniques to improve rainwater-use efficiency and conserve the soil. Digging basins for the purpose of conserving the soil is a technique applied in all the interviewed districts since it is a component of CA under promotion.

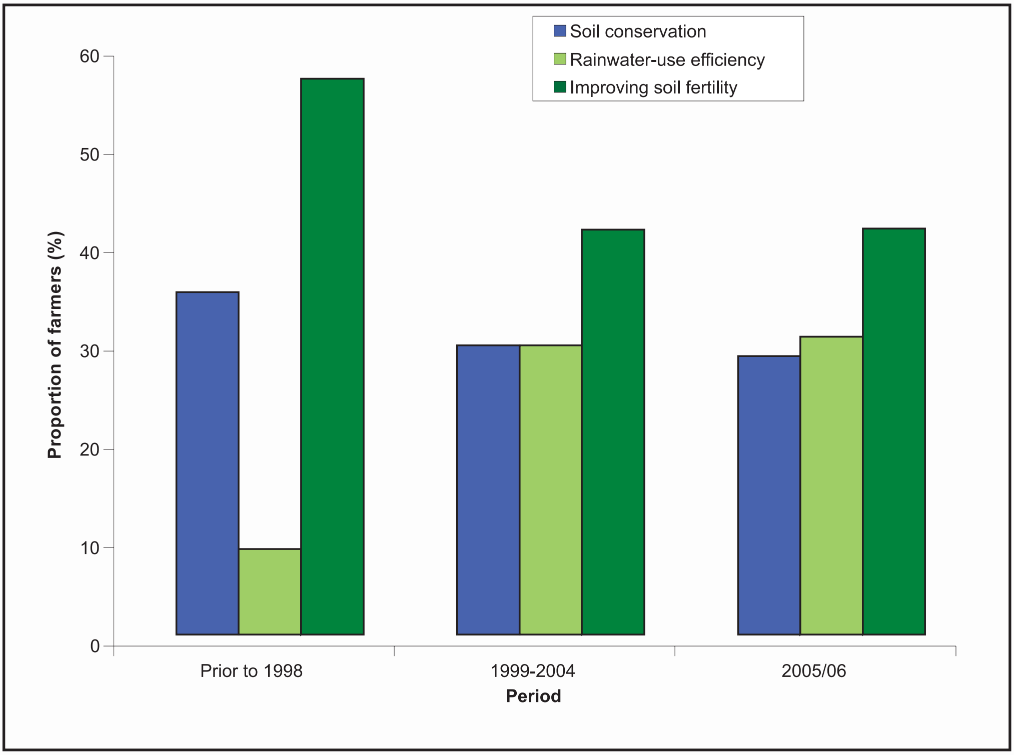

Figure 6. Increasing popularity of rainwater-use efficiency technologies over time (n=231)

Box 2. A point of clarification: Technologies are not yet practices

A technique or technology is a way to produce or organize, out of any context (invention), whereas a practice is a technique borrowed by social and economic context (innovation) (Ellis 1993).

Researchers and extension agents must acknowledge that adoption refers to adaptation. Technologies are seldom adopted and implemented as such. Farmers tend to adapt them to their needs and to the constraints and limitations they face. Through such adaptation an invention (the technology) becomes an innovation (a practice) (Perret and Stevens 2003).

4.4. Changing focus on soil fertility and water management training

Efforts to improve rainwater-use efficiency have increased with time mainly through the work of NGOs. Prior to 1998, extension advice was mostly targeted at improving soil fertility and soil conservation using top-down methods of technology transfer and dissemination. Due to declining rainfall

Table 4. Popular soil fertility and water management techniques used across districts

Techniques	20% or more of the sample reported using the technique in the district									
	Insiza	Mangwe	Matobo	Bulilima	Tsholotsho	Gutu	Chivi	Masvingo	Chirumhanzu	Zvishavane
Sample size (n)	24	11	21	10	24	19	34	31	26	29
Improving soil fertility										
Cattle manure	√	√		√	√	√	√	√	√	√
Chemical fertilizer	√	√		√	√	√	√	√	√	√
Rainwater-use efficiency										
Mulching	√		√	√	√	√	√	√	√	√
Digging basins	√	√	√	√		√	√	√	√	√
Infiltration pits		√	√	√	√		√		√	√
Tied ridges		√	√	√	√	√	√			
Soil conservation										
Mulching	√	√		√	√		√	√	√	√
Digging basins	√	√	√	√	√	√	√	√	√	√

Source: ICRISAT survey data (2006)

and persistent droughts, emphasis is now being placed on how to efficiently use every drop of water that falls as rain. The period from 1999 to 2004 saw two drought seasons which prompted researchers to develop techniques that improve rainwater utilization. The focus was on the use of crop residues as mulch and various forms of minimum tillage.

Agricultural extension using the master farmer approach was the sole provider of training in soil fertility and water management prior to 1998. The target group was the wealthy, educated and better-resourced farmers thus leaving out the poor vulnerable households who were labelled laggards. The number of farmers who received any form of training in terms of soil fertility and water management prior to 1998 grew six fold during the period 1999–2004 thanks to the FFS and efforts of NGOs such as World Vision, CARE, OXFAM, CADEC, ORAP, Community Technology Development Trust (CTDT), RUDO, and Zvishavane Water Project (ZWP). The figure on training received grew tremendously in 2005/06 (10 times the number prior to 1998) (Figure 7); many farmers received training from multiple institutions.

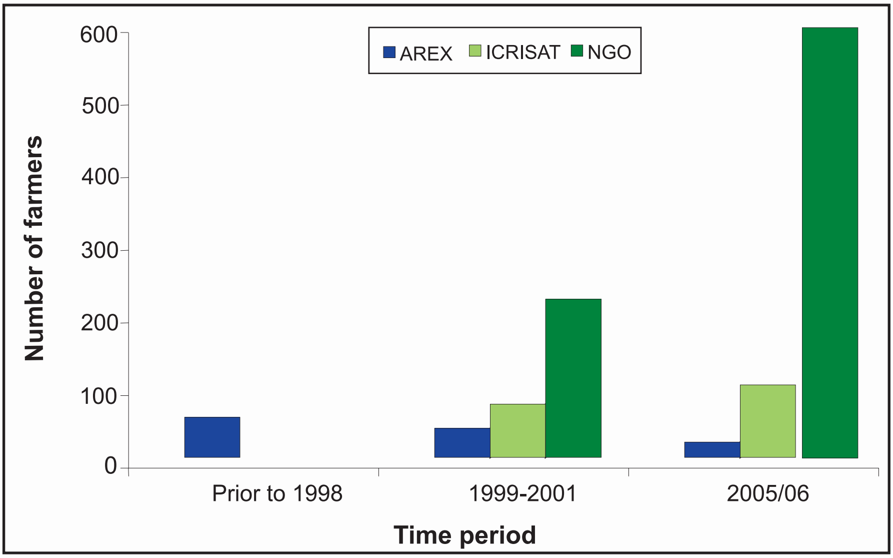

Figure 7. Increasing involvement of NGO in farmer training over time in the survey area

The number of NGOs operating at the grassroots level has been on the increase in Zimbabwe since 2000. Beginning in this period, NGOs and grassroots organizations continued to expand famine relief programs and distributed inputs and agricultural information to help poor households recover from natural disasters (Rohrbach et al. 2005). Most donors believe that NGOs are intrinsically innovative, flexible, and responsive to the 'grassroots', and are therefore the best means of channelling effective aid to the poor. In addition, as AREX has been experiencing a decline in resources, NGOs have acquired an even more important role in development work and technical support in communities. Although NGOs have thousands of staff and are better at engaging farmer participation in development, they have been criticized for lacking the scientific and technical expertise to complement their dialogue with the poor (White and Eicher 1999; Ryan and Spencer 2001). Similarly, Hove (2006) also recommended that most NGOs should adjust their staffing level and modus operandi in order to effectively implement CA and MD programs. NGO staff in charge of CA and MD should have qualifications in agriculture and should be contracted for at least 12 months. These concerns arose from a survey conducted in 2006 that showed that most of the NGO staff interviewed were not confident with planting basins, the technology most promoted (Hove 2006).

Farmers have identified ICRISAT as one of the organizations that provides training and technical advice on issues related to soil fertility and water management. Perhaps this is not surprising because the survey team represented ICRISAT and farmers wanted to identify with the Institute. The number of farmers trained by ICRISAT grew steadily with time (Figure 7) because of the Institute's role in the PRP. ICRISAT provided technical support to both extension personnel and NGOs and never operated in isolation in the communities.

4.5. Farmer participation in the study area

There are many ways to understand and induce participation of local people (beneficiaries) in development work. It is important to note from the onset that at this point of technology development, the focus is on technology evaluation and adaptation. These are not new innovations but technologies generated as a result of years of on-farm adaptive trials, testing, and modification by both farmers and researchers (Ncube et al. 2007). The level of farmer participation in this study was also restricted by the number of beneficiaries involved in excess of 200,000 vulnerable households.

Farmers are encouraged not to modify the trials and experiment because recommendations have to be followed exactly during the first year of hosting demonstration trials. ICRISAT and partner NGOs closely monitor the trials to understand where the constraints are in following the given advice. Farmers' engagement in these trials was to evaluate best-bet technologies developed by ICRISAT and partners beforehand with room to refine, validate, and adapt over time. Farmers are encouraged to try and see how the technology works. The demonstration trials provided an easy-to-implement technology package ideally suited to vulnerable households in the drought-prone area.

The technologies provided the best packages for farmers who were resource constrained with limited or no access to draft power. However, almost every farmer hosting the trial for the second year changed the trial to adaptive trials whereby the techniques were modified and improved. Those farmers who hosted trials were provided with fertilizer and seed.

For the purpose of this study the nature of farmer participation has been classified into passive and active participation. Passive participation is where the farmers are minimally involved as mere observers during trial implementation. Active participation, on the other hand, describes any level of activity ranging from merely holding a tape measure up to the level of decision making needed to choose the site of the plot. During the process of hosting trials, farmers indicated their level of participation at each stage of trial implementation (Table 5). Most farmers actively participated at all stages except during data collection where the greatest constraint was the use of a record book. Even though, farmers were actively involved in measuring the plots, their main role was limited to mere assistants who held the other end of the rope and put in a peg to just observing (Figure 8).

Table 5. Proportion of farmer participation by type for different tasks during trial implementation

Task	Active participation (%) (n=231)	Specific task	Total number of farmers doing task (%)
Site selection	84.0	Advised on available land	72.2
Measuring plot	89.2	Putting pegs	50.2
Managing plot	93.1	Providing all the labor required	91.0
Data collection	86.1	Recorded all quantities used and dates	81.0

Source: ICRISAT survey data (2006)

Though farmers were generally happy with the roles they played during trial implementation, more could have been done to improve their participation. Table 6 gives an indication of the suggestion put forward by farmers to improve their participation. Most farmers who worked in groups indicated that they would have selected centrally located plots if they were given an opportunity to make the decision. Teamwork was considered to be important during site selection, measurement, and management of the trials. Notably, farmers hosting trials for the first time requested more supervision.

Figure 8. Passive farmer participation during plot design and basin preparation

4.6. Farmer experimentation in participatory technology evaluation and adaptation

During the second and subsequent years of trial implementation, farmers made changes to the research protocols they received and this was important for the eventual uptake. Adaptation and innovations are essential components of the technology evaluation process and lead to empowerment. Farmers who did not make any changes to the trial protocol argued that they were still trying out the new technology and wanted to see if it worked. However, those hosting trials for the first time claimed that they were encouraged to follow the program precisely. The modifications farmers made addressed specific problems or constraints they faced (Table 7). The majority of the farmers did not change the trials in the first year because they tried to stick to the given instructions.

Farmers employed various means to solve the problems they encountered during trial implementation. The problem of rodents appeared in the second year of running the trials because during the dry winter months, rodents move into the fields to eat dropped grain and breed. When there is no spring plowing, the leftover crop residues are destroyed. Most farmers pointed out the problem of termites which fed on the maize stover, but in reality this should not be a problem to farmers because it helped in the breaking up

Table 6. Suggested changes to be made during trial implementation

Task	Changes to be made	Number of farmers (%)
Site selection (n=38)	Select site central to group members	66
	Choose plot with poor soils to see impact	16
	Increase spacing for maize	13
	Encourage to work as a group	5
Measuring plot (n=25)	Use tape measure	12
	Increase spacing for maize	20
	Encourage to work as a group	36
	Pacing is faster than tape measure	8
	Getting assistance from school children who are literate	24
Managing the plot (n=32)	Encourage to work as a group	94
	Select site central to group members	6
Data collection (n=43)	Select site central to group members	37
	Modify record book to be in calendar format and in vernacular	30
	Getting assistance from school children who are literate	23
	Extension/NGO to visit frequently as an encouragement	9

Source: ICRISAT survey data: (2006)

Table 7. Reasons for modifications and the related adjustments made by farmers

Reason for modification	Recommendations before adjustments	Adjustments made to the advice	Number of farmers (%) (n=58)
Labor constraint	Weeding three times harvest and once in winter	Reduced frequency of weeding to once/twice	21
	15 cm × 15 cm × 15 cm basin	Reduced basin size	16
	90 cm × 45 cm × 45 cm pit	Reduced size of infiltration pits	9
Easier application of fertilizer	Apply fertilizer using a bottle cap	Hand application of fertilizer	19
		Use of teaspoon to apply fertilizer	14
Could not afford recommended fertilizer amounts	One handful of manure	Applied manure only	16
	One bottle cap per basin	Reduced amount of fertilizer	12
Capture more water	15 cm × 15 cm × 15 cm basin	Increased basin size	19
	Open furrow using a ripper tine	Digging along the ripper furrow	5
Recommended fertilizer too little	One bottle cap for two plants	Increased the fertilizer applied	16
Too much rains	One bottle cap for two plants	Increased the fertilizer applied	12
Animals would feed on crop residue in the field	Leave maize stalks in field	Applied crop residue later	7
Crops too crowded	90 cm inter-row × 60 cm in-row	Increased basin spacing	9

Source: ICRISAT survey data (2006)

of maize stover. Another problem with mulching using crop residue was its destruction by stray animals especially during the dry season. Animals are allowed to graze freely in the winter and often end up feeding on the mulch. Grazing land is common property and one cannot exclude other people's animals from their fields. Fencing may provide an effective control but the cost is prohibitive. The alternative is the use of live fences or children to guard the fields. This, however, has a cost implication that can ultimately reduce the welfare gains from the technology. A summary of the general nature of the problems encountered is shown in Table 8, though 54% of the problems that were reported in their various forms were not resolved. This is important feedback information to scientists as it sets the agenda for further research.

Table 8. Problems and solutions for the trials hosted (n=231)

Problems encountered during trials	Number of farmers encountering problem (%)	Measures put in place	Number of farmers using the measure (%)
Problem of rodents/ termites due to crop residue	20	Used traditional practices (sand, ashes, treated with certain plants)	38
Stray animals	17	Protected the plot by fencing or guarding	46
Labour constraints	16	Pooled labour by working in groups	26
Problem of invasion by worms/birds (seasonal)	13	Used traditional pesticides (special ashes, wild plants)	50
Lack of fertilizer	10	Used manure instead of fertilizer (farmers allowed to choose between manure and fertilizer)	38
Too much rain/wind	7	Replanted destroyed crop	59
Various problems	53	Unresolved	100

Source: ICRISAT survey data (2006)

4.7. Changes incorporated into farmer practice

Farmers who hosted trials managed to learn and adopt a number of practices that they incorporated into their normal farm operations. Most of these practices are linked to the aims of the trials. In the case of conservation farming, 56% of the respondents indicated that they realized that the aim of the trial was to learn the payoffs of using own labor when faced with a draft power constraint. Consequently, most of these farmers could now plant in time since they no longer had to wait to borrow draft animals. Winter weeding still poses a challenge to farmers though it has no direct clash on the farmers' labor. Most farmers do not undertake this activity because winter is the time for gardening and all field activities have to come to a halt. Smallholder farmers generally grow three cycles of crops per year. Typically, this includes at least one cycle of vegetable crops during the winter months and an early maize or bean crop that can be harvested in December. Winter weeding and the use of maize stover for mulching have not become common practices because of the implications on farmers' time and infringement on the free movement of cattle in winter. Other practices that have been adopted are summarized in Table 9.

Table 9. Adopted changes brought about by hosting trials

Changes in farmer practice	Proportion of farmers implementing the change (%)	
	Conservation agriculture (n=194)	Microdosing (n=37)
Use of bottle cap to apply fertilizer	36.1	62.2
Use of fertilizer as fertility amendment	9.8	24.3
Targeted application of plant nutrients	27.3	35.1
Timely planting	17.5	N/A
Minimum tillage	79.9	N/A
Mulching using maize stover	4.6	N/A
Winter weeding	1.5	N/A

Source: ICRISAT survey data (2006)

Farmers adopted some changes to their old practices because they had learned better ways of managing soil fertility and water. Those farmers who were just trying out a new technique did so in anticipation of better yields. A comparison of the old and new practices adopted highlighted the driving force behind the change (Table 10). Targeted application of nutrients and the use of bottle caps to apply fertilizer are the most popular techniques that have been adopted by those who practiced CA and MD.

Almost all farmers who hosted CA trials have acknowledged the incorporation of minimum tillage into their normal practice. Different forms of minimum tillage, ranging from digging basins, furrows and using a ripper tine, were readily accepted by the farmers. Trials provide an opportunity for learning, which reduces uncertainty and improves decision making. Information generated in the trials enables farmers to revise their subjective beliefs about the profitability of the new technology and to decide whether or not to continue using it and what resources to allocate to it (Rusike et al. 2006)

Table 10. Reasons for moving away from the old practices

New practice	Old practice	Reasons for changing
Use of chemical fertilizer	Use of cattle manure, anthill soil, ashes and compost	Got access to fertilizer through programs
		Fertilizer makes crops grow fast and improves soil fertility
Targeted application of nutrients and microdosing	Broadcasting	Economical and efficient way of applying fertilizer
Minimum tillage (digging basins)	Summer plowing	Enables maximum water use per plant
	Contours and storm drains	More effective in soil erosion control
Mulching	Winter plowing	Improves water retention by soil
		Improves soil fertility

Source: ICRISAT survey data (2006)

4.8. The technology transfer process

ICRISAT has promoted MD and CA technologies on a large scale since 2005. The program started off by training NGO personnel who would promote the technologies at grassroots level. In subsequent years extension workers in the areas where CA and MD were being practiced were trained as part of the technology transfer process. The largest promotional activity was through experiential learning plots where farmers would see, do, and learn. This provided the greatest conduit for moving the technology from researchers and extension to farmers. Traditionally, demonstration plots are planned and managed by extension staff and farmers would simply observe and learn. Also, a deliberate effort to promote CA and MD was made through promotional materials. In 2005, more than 200,000 flyers were distributed across all participating districts. Posters were also used at central locations as ways of disseminating information on the two technologies.

The majority of farmers (80%) confirmed that they had an opportunity of discussing trial results. Trial results were discussed at different platforms as shown in Table 11. Field days, farmer meetings and shows (fairs) ensure that a larger audience was addressed though they are costly to implement. Field days and shows (fairs) are paramount in ensuring that tangible evidence is available in the farmer's field. The same methods were also used as platforms for spreading information to other farmers. Farmer-to-farmer extension was the most popular transmission vehicle used by more than 70% of the farmers.

Farmers felt free to communicate their skills and experience with all members of the community. Once this level of communication flow is reached in communities, farmer-to-farmer sharing becomes quite dynamic as would be the case in all participatory approaches. Strategically located trial plots tend to attract the attention of all neighbors, silently transferring information.

One of the primary benefits of attending field days was interaction with other farmers as shown in Figure 9.

Field days are one-off events that leave a lasting impression unlike farmer meetings that have to be attended regularly. Field days proved to be an important platform for presenting results to the female household heads (Table 11). Farmer meetings were mainly used to reach male household heads because they are not faced with a time constraint compared to their female counterparts. Women normally have other commitments and are often unable to attend regular meetings. Given the sample size (231), the extent of contacts between farmers and various methods (Table 11) can be generalized to be quite high by African standards.

Table 11. Proportion of farmers who were reached by the various methods used to present results during 2005/06

	Method			
	One-on one	Meetings	Shows	Field days
Male (n=102)	26	29	1	43
Female (n=73)	26	19	0	55

Source: ICRISAT survey data (2006)

Figure 9. Farmers at a green field day in Masvingo; field days have the potential to disseminate information to many farmers

4.9. Impacts of technology on the community welfare

The majority of the farmers claimed that the technology had a positive impact on community welfare though some could not distinguish between the benefits attached to the technology and those of the project. The direct incentives that were attached to the project such as access to free inputs were cited as a benefit and the increase in yield was accredited to both the technology and free inputs. Figure 10 shows what farmers perceived to be possible causes of an improvement in community welfare. Close to 80% of the respondents cited yield increases as the most important cause of improved community welfare. However, a fifth of the respondents alleged that their welfare was not improved by hosting trials. This was a result of poor yields due to too much rain. With excess rainfall the nitrogen fertilizer was heavily leached rendering it unavailable to crops. The yield obtained was below expectation and, in most cases, the yield of the farmer practice plot was higher than that of the trial plot, especially among MD trials in Zvishavane and Chirumhanzu.

Access constraint in terms of fertilizer availability was a key issue. However, the issue of liquidity or access to credit was not considered important enough to hinder technology adoption. Liquidity constraint was not expected to be an issue with these farmers because they were selected on the basis of their vulnerability; they represent farmers who are at risk. Female household heads consider access to free input as an important contributor to welfare improvement and also the ability to share knowledge with other farmers. The factors are not given high value by their male counterparts probably because

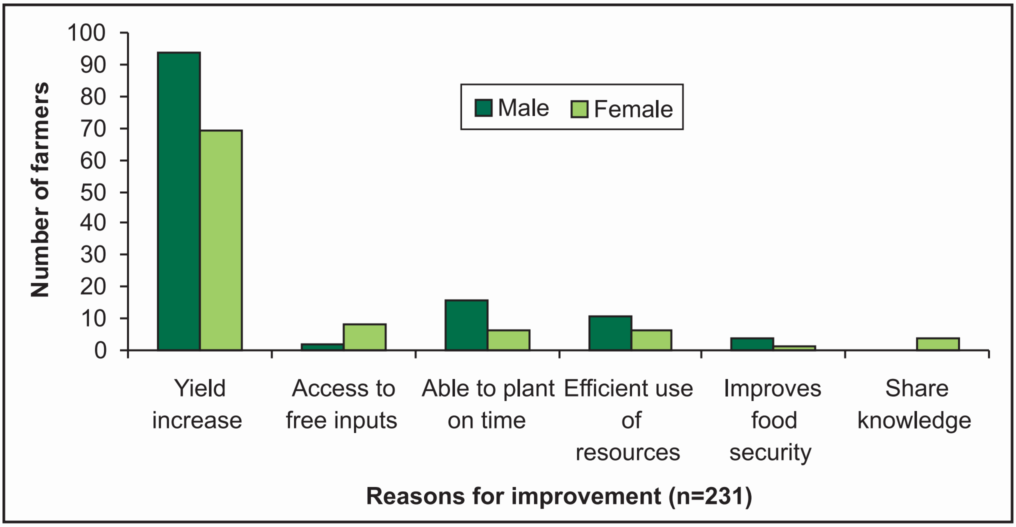

Figure 10. Factors perceived to affect changes in welfare

it is often the female-headed households that are constrained in terms of resources and information. The male-headed households gave greater credit to the ability to plant on time as well as an increase in yield.

4.8. Farmers feedback

Farmers had suggestions on how the hosting of trials could be improved; this critical feedback is essential in a participatory process (Figure 11). If the information is incorporated in future programs, farmers would feel a sense of ownership, boosting their confidence, and leading to wider adoption.

Generally, female-headed households indicated a greater preference of working in groups as they believed it incorporated more community members in the program. Getting more training and stricter supervision is fundamental to them as a way of boosting their confidence. On the contrary, male-headed households demanded delivery of inputs on time and wanted to further experiment with different crop varieties. They even requested for the trial plots to be increased in size. Male-headed households are primarily concerned with the technical issues; their female counterparts raised issues that were purely social.

Respondents were encouraged to ask questions and make any comments pertaining to the interview. More than half of those who asked questions wanted to know whether the allocation of trial inputs could be increased. Some farmers were grateful for the assistance and expressed appreciation but others asked for incentives such as t-shirts, caps or hats which could help to identify them as project participants.

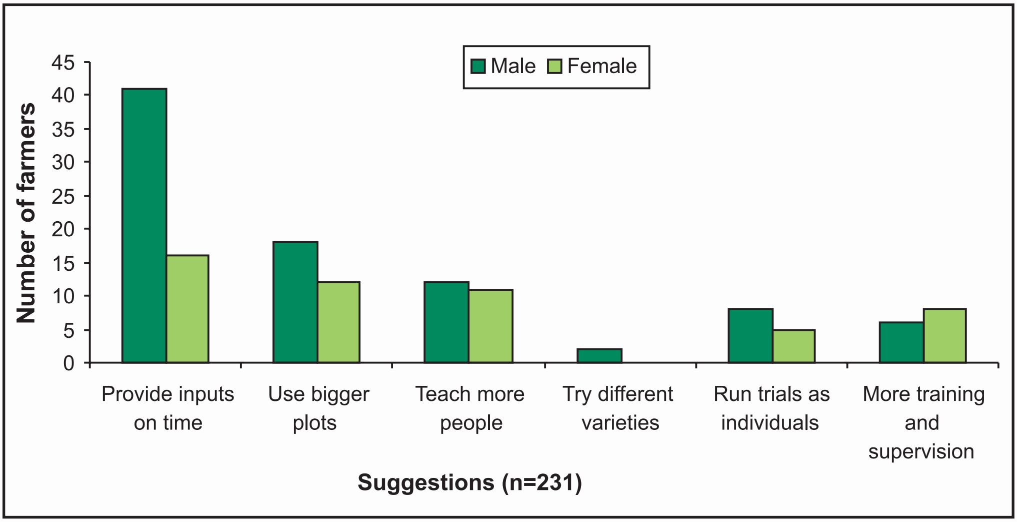

Figure 11. Farmer suggestion on how best to run trials

The farmers also raised another concern related to the administrative issues of the implementing NGOs. The issue of delays in input distribution was pointed out as requiring corrective action and there were requests for an increase in the level of supervision which was deemed low or non-existent. Some farmers requested an increase in the size of demonstration plots as well as incorporating more farmers who were interested to ensure greater participation. For the continuity of the program, farmers requested more information on CA because it is a knowledge-intensive technology requiring a longer learning period. In addition, some farmers felt that fertilizer should be available at local shops to improve access.

Farmers, who were hosting trials in the second year, had carry over problems arising from previous trials. The major concern was dealing with termites attacking the crop. Concerns were raised on the possibility of implementing other farming methods on the former CA plot after harvesting. In line with that, farmers wanted to know why they were not allowed to practice conventional tillage when they did not have a draft power constraint. This could have been a problem of beneficiary selection by the NGOs because CA was meant for farmers with a draft animal constraint.

Some farmers felt that sorghum and millet should be planted in the trial plots as they performed better compared to maize especially under moisture stress. However, one farmer in Chivi acknowledged having improved his maize yield tenfold. Most farmers praised the technology and alleged any poor crop performance to their failure to follow the recommendations as advised.

Table 12 gives a summary of farmers' perceptions on the process of technology development and transfer with special emphasis on the approaches used, the behavior towards farmers and farmer involvement during project implementation. The purpose of this inquiry was to take note of the strong points and areas that needed correction in the event of farmers complaining. Due to the diversity of farmers and NGOs involved, a homogenous view could only be captured while diversity of views was hidden in numbers. Generally the comments were positive as would be expected because farmers were not so sure of the implication of any negative comment they give.

In terms of the approach towards farmers, most farmers acknowledged that local leadership was consulted and the purposes of the visits were always explained at a public forum. Local extension officers always accompanied the visitors, a practice welcomed by the farmers. A few individuals felt they were rushed into the program and it was necessary for them to be given adequate time before they got involved. More than 65% of the farmers testified that they were respected and treated well.

Table 12. Farmers' perception on the technology development and transfer process (n=231)

Issue	Farmers' comment	Number of farmers	Proportion of farmers (%)
Approaches towards farmers	Consulted local leadership	127	55.0
	Accompanied by extension officer	79	34.2
	Explained objective at a meeting	17	7.4
	Farmers need more time before they get involved	2	0.9
Behavior towards farmers	Happy, friendly, respectful to farmers	151	65.4
	Used language that was understood by farmers	63	27.3
	Should speak in a language that villagers understand	8	3.5
	Should treat us with respect even if we do not know	5	2.2
	Treated everyone as a potential farmer	3	1.3
Involving farmers	Farmers given a chance to participate and ask questions	85	36.8
	Farmers were included in the planning	60	26.0
	Farmers should be involved in the actual planning of the program	43	18.6
	Treated everyone as a potential farmer	27	11.7
	Farmers not given a chance to participate	6	2.6
	They should explain why other farmers were excluded	6	2.6
	We volunteered to participate	5	2.2
Tools	Tools were user friendly and appropriate	94	40.7
	Provide more tools to farmers	57	24.7
	Should bring appropriate tools for the job	36	15.6
	Should bring tape measures	32	13.9
	Improvise where tools are not available	12	5.2

Issue	Farmers' comment	Number of farmers	Proportion of farmers (%)
Substance in what is being taught	Technology works	160	69.3
	Training workshop were good	52	22.5
	Practical lessons helped a lot	19	8.2
Methods used	Methods used were understandable	112	48.5
	Group discussions	52	22.5
	One on one	36	15.6
	Practical lessons helped a lot	16	6.9
	Training workshops were helpful	6	2.6
	Train farmers more frequently	5	2.2
	Record book should be in vernacular	5	2.2

Source: ICRISAT survey data (2006)

5. Conclusions and Recommendations

Farmers were able to pick up techniques they found to be useful and appropriate. This explains why only a few farmers practiced winter weeding and mulching using maize stover. With experience farmers gained more confidence in the use of the technologies and were able to experiment with them. Useful innovations were generated in the process, including using thatching grass as mulch, using a teaspoon for applying fertilizer, and using indigenous knowledge to deal with pests. Conventional methods of applying fertilizer such as broadcasting fell out of favor in preference of more economic methods of targeted application of inputs. It is apparent that every farmer who hosted trials managed to change his/her farmer practices and managed to learn and adapt certain aspects of the technology. This gave farmers a chance to own the process of technology development through their own modifications. The participatory nature of the process encouraged more sharing among farmers, especially those who worked in groups.

Farmer meeting shows and field days were important platforms for showcasing the technology and proved to be efficient methods for farmers to share experiences and knowledge. More than 80% of the respondents attested that their yields had increased or there was an improvement in food security. The adoption of the soil fertility and water management techniques resulted in farmers increasing their food security and overall cereal production.

It must be noted that these technologies were not introduced under traditional participatory technology development projects but under recovery and relief programs. Even though the project donors were specific on the beneficiary groups, farmers advocated the involvement of the whole community right from the start as a way of ensuring a high level of participation. A community approach would increase acceptance and avoid victimization of individuals or labelling such as "Farmers of XYZ" referring to a particular NGO. Working with a subset of farmers is not necessarily incorrect, but ignoring their relationship to the rest of the community can lead to erroneous generalizations and limit the scope of research and its results. More so, farmers should be encouraged to work in groups in order to promote learning and encouragement so as to ensure higher adoption rates and wider discussion and access to knowledge.

The focus of research and NGOs should not solely be on the technology but also take into consideration how it fits into farming systems given the competing demands on household labor and there should be feedback loops to allow improvements and modifications to be made to the techniques. The nature of demos and aims of trials need to be clearly defined to the participants so that there is no compromise on the scientific quality of the research.

Participation is a process that should be continuous and requires a longer timeframe than traditional top-down approaches. Participating NGOs should be encouraged to include community structures in their projects as a way of ensuring sustainability. Where the beneficiaries are defined by the donors, as is the case in this study, NGOs should improve their selection criteria so as to capture the intended beneficiaries. In addition, material support of farmers should only be given to first-time experimenters so that others will use the technology because they see value in it.

It is paramount for both research and farmers to move beyond experimentation towards marketing and scaling up of innovations. The ultimate aim is to leave the community with the capacity to implement effective process of change. Participatory technology development programs are therefore concerned with organizational development and the creation of favorable conditions for ongoing experimentation and development of sustainable agro-ecological systems. The role of outside participatory technology development facilitators gradually changes; their attention shifts to their communities in order to promote participatory technology development on a wider scale. This can be achieved by improving input supply at the local retail shops as a way of enhancing access to purchased inputs such as fertilizer. Small affordable fertilizer packs should be made available locally as ways of promoting technology adoption in a sustainable manner.

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About ICRISAT

ICRISAT
Science with a human face

The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) is a non-profit, non-political organization that does innovative agricultural research and capacity building for sustainable development with a wide array of partners across the globe. ICRISAT's mission is to help empower 600 million poor people to overcome hunger, poverty and a degraded environment in the dry tropics through better agriculture. ICRISAT belongs to the Alliance of Centers of the Consultative Group on International Agricultural Research (CGIAR).

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