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Towards convergence of participatory innovation processes and formal research in soil and water management — an example from Zimbabwe[1]

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The paper describes elements of the methodology and tools that have been developed and applied in participatory technology development and extension activities in Masvingo Province, Zimbabwe. It shows that farmers who learnt to understand biophysical processes on their fields, had a higher capacity to generate creative land husbandry solutions. Major challenges have been the integration of quantitative research into this process and the institutionalization of the participatory approach.

Résumé: *Dans cette étude, nous décrivons les éléments de la méthodologie et des outils développés et utilisés dans le développement des technologies participatives ainsi que des activités de la vulgarisation dans la province de Masvingo, au Zimbabwe. Elle montre que les cultivateurs ayant appris à comprendre les procédés biophysiques sur leurs champs étaient beaucoup plus capables de générer des solutions créatives d'aménagement du sol. Les problèmes majeurs sont d'intégrer dans ces procédés de la recherche quantitative et l'institutionnalisation de l'approche participative.*

Introduction

Participatory research and extension in southern Zimbabwe has shown that land literacy leads to improved and creative land husbandry. Farmers who have learned about the dynamics of their environment are able to develop and apply small, site- and situation-specific measures for soil and water management rather than depending on standardized

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soil-conservation methods. While teaching and demonstrating standardized techniques and practices are central to conventional extension work, they perpetuate farmer dependence on solutions from outsiders.

The objective of this paper is to describe elements of the methodology and tools that have been developed and applied in our participatory technology development and extension activities in Masvingo Province in Zimbabwe. A major challenge has been the integration of quantitative research into this process due to the diversity and dynamics of the socio-economic and biophysical environment.

Conventional extension

For many years conventional extension practices in Zimbabwe emphasized oral teaching as farmers were frequently assumed to be illiterate and little effort was allocated to tools and methods that encourage farmers' individual learning. Women who carried out most of the farming operations were considered simply as farmers' wives and therefore felt inhibited in the male-dominated groups rather than feeling encouraged to become involved actively in extension training. Soil conservation has always been an important topic in extension in Zimbabwe. It was promoted through coercion during the colonial era and later through promises of higher yields and sometimes through food for work. The fact that farmers adopted techniques such as mechanical contour ridges and waterways in more than 90% of their fields seems impressive and promising. A less favourable picture emerges, however, if the impact of soil-conservation measures is taken as the critical indicator rather than the extent to which farmers adopted soil-conservation techniques. Recent research showed that in two thirds of the fields studied contour ridges did not stop erosion but often accelerated it (Hagmann, 1996). These results questioned the validity of extension targeted on the adoption of blueprint technologies by farmers.

Introducing a participatory approach

As an entry point for building trust between farmers and researchers and to get the research process started, farmers were familiarized with several conservation tillage techniques. These techniques corresponded to their priority needs in the semiarid area, namely water conservation. One technique, tied ridging, was suggested for further joint testing and development in farmer-managed and farmer-implemented adaptive trials. In workshops principles of Freire's (1973) "Training for Transformation" were introduced to catalyze active farmer participation, experimentation, and openness in the farmer groups. A problem analysis was carried out and mutual roles and expectations as well as a simple trial design were clarified and agreed upon. After the first year when trust and the farmers' spirit of curiosity had been developed fully, the researcher-initiated process was taken over by farmer-initiated experimentation on various aspects of land husbandry while testing and development of tied ridging continued.

Development of soil and water conservation together with farmers showed that small, site-specific measures such as building check dams in rills, leaving grass strips, and creating small barriers to prevent concentrated flow from anthills and depressions are more effective than standardized mechanical conservation designs. However, if farmers are to benefit from the superior soil- and water-conservation potential of these techniques, they need to be able to "read their land". By exploring the causes and effects of soil erosion and monitoring them in their own fields, farmers come to an understanding of biophysical processes. They must also have access to a variety of ideas and technical options so that they can experiment with and identify the strategies most suitable for their specific site and situation.

How to raise farmers' capacity and interest in land husbandry?

The most effective, pedagogic way to come to an understanding of complex issues is "learning by doing", "action learning", "experiential learning", and "discovery learning". All these principles stress the need to get involved in action and debate to build up experience, share it with other people, and learn more in an iterative process of action, reflection, self evaluation, and new action. Instead of being taught techniques in extension, farmers are inspired to analyze their situations together, to put forward and try out their own ideas and known technical options. These experiences and lessons are then shared with other farmers and the larger community.

This approach to technology development and extension is being practiced in our activities in southern Zimbabwe. It contains an individual and a collective, social learning component. The main learning method is experimentation and sharing. In putting these principles into practice we use a variety of "learning tools" by which farmer awareness is increased and processes are discovered.

Tools and methods for learning and farmer motivation

There is a variety of tools and methods that can be used to stimulate the process of group exploration, discovery, and learning. Some of these are described below.

Tapping visions and values

In community workshops we initiate this learning process by stimulating debates on people's visions of development. With questions such as "If you came back as a spirit in 100 years' time, what would you like to see in your village?" people were stimulated to think about nonmaterial values. The subsequent discussions often reflected a farmer's concern for environmental issues. These debates were guided towards retrospection (for example, mapping) and to exploring the reasons for environmental and social change. Raising awareness through debate and the joint analysis of change combined with social learning activates negotiations on values and social norms and creates interest in working towards the visions formulated in the group.

Comparing soils

Two simulated soil profiles contained in glass boxes with an outlet at the bottom are compared (see proceedings cover). One profile is eroded and as a result has a shallow topsoil. The other profile simulates well-managed, noneroded soil. An equal amount of water is poured into the two soil columns. The shallow, eroded soil has a lower water retention capacity and half of the water immediately flows away. The noneroded profile is able to hold water. Having observed this simple experiment, the farmers' learning process is facilitated by such questions as "What happened?", "Why did it happen?", "What effect has this on plants growing on these soils?", "Have you seen this happen in your fields?", "What is the effect in your field and has this changed over the last few decades?". In this way farmers discover and analyze biophysical principles and relate them to their situation. The analysis reveals the link between the (man-made) drought and soil erosion.

The rainfall simulator

Three fields – one ploughed, one ridged, and one mulched – are compared during a "rainstorm" induced by a watering can (see proceedings cover). In reality these fields were boxes (see Elwell, 1986), measuring 0.3 x 0.5 x 0.1 m with an outlet at the bottom and a chute at the top. Runoff, soil loss, and groundwater outflow were collected in glass beakers from the three "fields". High runoff and soil loss occurred on the ploughed field, whereas on the mulched and ridged fields runoff and soil losses were low and groundwater outflow was high. Questions similar to those mentioned above were asked to encourage farmers to analyze these observations and relate them to their own environment and practices.

Metaphors and codes

In the discussions the use of imaginative language from the farmers' lives is encouraged. For example, a farmer compared the dynamics of water in the soil to the workings of blood in the body; a gully becomes a wound that allows blood to drain away. This is related to the drying up of wetlands through gullies. Such metaphors together with songs, stories, proverbs, and dances are used to relate environmental processes to the farmers' everyday reality. Pictures of degraded landscape, for example, with people struggling to get firewood or games such as the "nuts" game, that simulate the use of common resources, are also important. Role play depicting situations in play form help rural people to analyze their own situations from a distance. These codes provide an entry for a debate on farmers' perceptions. The type of facilitation that takes place, however, is extremely important. First, questions on the situation depicted in the picture/game/role play are asked and these are then developed into questions that create links with the "real life" situation. The farmers then discuss the various answers generated by the group. The facilitator function is restricted to summarizing the discussions and guiding the process.

"Think tanks"

Think tanks where numerous technical options are shown in the field are used to expose representatives selected by communities to the technical options open in land husbandry. In our case the sources of these innovations are creative farmers, training centres, and research stations. Visits to think tanks have become so popular that farmers, on their own initiative hire and pay for buses to visit these locations themselves. Feedback to the community after such excursions is an extremely important step in encouraging other community members to experiment with new ideas. Visits by farmers have also had the effect of introducing changes at the research-station level. Farmers' feedback has encouraged researchers to test and demonstrate farmer-generated technologies on station.

Comparison

Conventional practice and new ideas are compared by placing them side by side in one field. The possibility of making comparisons in this way allows farmers to continually monitor and analyze what they see. This leads to an understanding of the processes and factors that influence the performance of technologies (learning by experimenting).

Competitions for the best ideas

The farmers' own way of experimentation was further encouraged in a "competition for the best ideas" and used as technology and an idea pool to be screened every season. The experimentation process was called *kuturaya* (meaning: "Let's try"). About half of the innovative ideas were adaptations and modifications to externally introduced ideas and options. The other half originated from farmers. In several cases ideas from outside were brought in, farmers modified the techniques and then the innovation was developed further jointly to a stage where it could be promoted. In other cases, researchers were inspired by the farmers' practices and ideas, and then further developed the innovation together with the farmers. Farmers' trials/experiments were evaluated jointly by the farmer groups, researchers, and extensionists during the growing season in a qualitative manner and quantitatively in feedback/planning meetings after the results had been analyzed. As many farmer-initiated trials and ideas showed high potential but did not allow a quantitative comparison, they were screened jointly for either further testing and development using the simple paired design, for further testing on the research station or for promotion if the idea was extremely successful and clear (Hagmann *et al.*, 1997a).

Such competitions help to revive the farmers' own knowledge and generates a willingness to try out novelties. In many communities "trying out" has become a new, positive social norm and the fear of failure in an experiment has been minimized. This spirit has replaced the tendency to wait for outsiders' solutions and has given new value to farmers' knowledge. To avoid innovators being victimized by fellow villages, a two-way competition has been introduced: Individuals in a community compete, but different communities compete against each other. In this way innovators are accorded more respect by their community; while it is also in their interest, if they are to win, that as many ordinary farmers as possible copy their ideas. Criteria for judging the competitions are set by farmers in cooperation with extension workers.

Sharing knowledge and experiences

Experience gained during field days, farmer evaluations, exposure visits, and workshops, for example, are extremely important tools in facilitating group/social learning. They also ensure that most community members have equal access to knowledge. The presentation of farmer's individual experiments and experiences to others can strengthen his or her confidence and pride.

Integrating formal research into the participatory approach

With regard to collection of quantitative data in the research process, it was possible by means of frequent interaction and observations to merge the participatory innovation process with quantitative research. The quality of the data improved with the building up of farmers' experimental capacities. Variability in soil and fertility was so high, that reasonable results were obtainable only when closely spaced paired checkplots were utilized. Provided farmers had fully understood the basics of small-scale experimentation and provided enough observation during critical times (e.g. planting, harvest) is guaranteed by researchers, checkplots cater for data quality that satisfies scientific standards. Data quality in farmer-managed/implemented trials without frequent contact with farmers proved to be highly questionable. The same applied to farmers' records, which were only of good quality (for researchers) if the researcher showed strong interest and requested them on a weekly basis.

The analysis of the quantitative research data showed that the performance of a certain technique significantly depended on the farmers and their management as an overriding factor. This proved to us that the development of one extension message cannot work. Recommendations would have to be extremely site- and situation-specific; a requirement which no extension service could provide. These facts made us rethink the conventional extension approach.

An understanding of processes determining the performance of certain techniques necessitated a combined analysis of several methods to evaluate the performance of the tested techniques. The following methods are applied:

- The core method for the researcher-driven quantitative technical evaluation is a simple paired treatment design where the traditional practice as a control plot is put alongside the improved technique in the same field (Figure 1). After explanation of basic principles of comparison (e.g. for tillage: Same planting date, same population, same fertilization rates) farmers manage their trial fields and observe the performance of the two treatments.

  The paired treatment design with only one variable proved appropriate and has not only enabled farmers to compare the performance of new techniques, but also enabled researchers to obtain quantitative data. Check plot pairs that are closely spaced in order to avoid high variability in soils and fertility are marked by the researchers. These check plots are utilized for further quantitative measurements and allow for more control by the researcher without interference and sacrifice in farmers' management and practicability of implementation (as in completely randomized block designs). Analysis of results is carried out on the basis of the relative performance of the improved technique to the traditional technique. For statistical analysis each farmer's field is considered as a randomized block with five replicates.

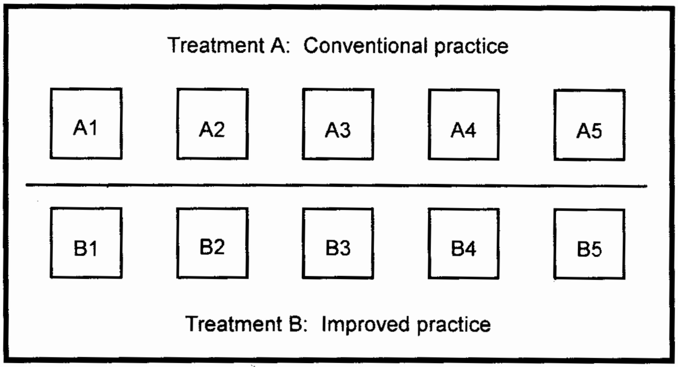

Figure 1. Paired treatment design with five plot pairs within one field. The two plots of one pair (each 5 x 5 m) are spaced closely to avoid high variability in soils and soil fertility. Slope positions of the treatments (sited upslope or downslope) are randomized over different fields. Slopes are between 1 and 5%.

- Qualitative observations and informal discussions with farmers during weekly visits. This tool has proved to be the most successful method to monitor farmers' trial management and adaptations. The continuous, long-term interaction with individual farming families revealed farmers' rationales and attitudes towards technologies as influenced by coping strategies within their livelihood systems. It also revealed that farmer circumstances are highly diverse and variable between families and dynamic within families.
- Joint evaluation tours with sharing of experiences and results in group discussions among farmers revealed farmers' understanding of the techniques and the processes and provided additional information on the implementation.
- Formal questionnaire surveys are utilized to identify the attitudes of participating and nonparticipating farmers towards certain techniques.

Contradictory hard and soft data

In an in-depth analysis the results of the quantitative and qualitative methods were combined. However, high quality and reliable quantitative (hard) and qualitative (soft) data emerging from both on-station and on-farm research were often contradictory.

Tied ridging, for example, had significantly lower yields than the conventional practice on station whereas on farm this technique improved yields significantly. Factors like variability of soils, of fertilization, and of farmers' management influenced the performance of the technique greatly. The performance of tied ridging between farmers was also highly variable and the statistical analysis of the hard data collected on farm showed that the farmer as a factor was always significant in terms of yield, labour requirements, emergence etc. Farmers' management was the overriding factor that determined the failure or success of the technique.

Methodologically the question here is how to separate the impacts of soil management technologies from the effects of other agronomic practices and farmers' management skills. Researchers are looking for quantitative results, while the high degree of variability of yields of the same technology from farmer to farmer is a reality. But the social environment is also highly dynamic. For example household leadership can change quite rapidly within a season, for example if the male head of a household takes on employment. The importance of understanding farmers' circumstances and their decision-making criteria is crucial in technology development (Chuma, 1996). Related to this issue is the dynamic nature of production constraints particularly in the semiarid areas. For example in a drought year, water harvesting techniques are a key to soil management whereas in a wet year water harvesting becomes totally irrelevant and waterlogging becomes a problem.

The diversity of results forced farmers and researchers to analyze the underlying factors and processes influencing the performance. Only farmers' qualitative analysis monitored through informal observations and discussions and in joint evaluation tours could explain the variable hard data and to understand the processes. Numerous farmers' techniques, ideas, and modifications from farmers' evaluation based on soft data were taken to the research station to quantify under controlled conditions and to understand the processes and interaction between various factors in more detail. During workshops and "look and learn" visits to the research station that became a "think pool for technology options", these hard data were again fed back to farmers who commented and explained the causes and effects from their perspectives. In general, however, farmers' evaluation of technologies valued qualitative criteria like risk, labour distribution or simple criteria like size of cobs and yield of the total field higher than the hard data provided by researchers. The major advantage of the paired design for farmers was the direct comparison that facilitated the analysis and understanding of processes (learning by experimenting). However, some of the effects are not always significantly measurable in the first season. The impact of soil management technologies particularly soil-erosion control techniques on soil quality tends to be long term. This was confirmed in an on-station experiment to evaluate four conservation tillage systems in southern Zimbabwe, where the conservation impact of the best system due to changes in soil organic matter only became apparent in the sixth year (Chuma and Hagmann, 1995). The question is how to reconcile long-term objectives of soil conservation with short-term requirements of crop production. In these cases, tools such as the rainfall simulator (see above) can be very helpful to visualize and valorize the expected outcome of the treatment. In our case, the direct impact of water conservation in a semiarid area was a strong argument for farmers to opt for soil-conservation techniques.

Lessons learnt

Farmer participation

The methods that were applied in farmer workshops to encourage farmer participation were highly effective in the implementation of the participatory approach. Participation, however, was not only generated through the workshops, but even more through farmers' full involvement in the choice of the technology, in the planning, and in the evaluation of the trials and through frequent visits of the researchers on the farms where a stimulating exchange of ideas took place. However, during the first three years it was also realized that farmer participation is not a method but a gradual process that has to be learned and gradually developed by all actors (researchers, farmers, and extension workers). A relationship based on mutual trust is the basis. This, and with it the success of a participatory approach depends largely on the personalities of researchers and extension workers and their personal attitudes towards farmers. Researchers and extensionists should have exceptional ability to empathize, a commitment to share a part of the farmers' lives and accept farmers as equal partners. In a society where small-farming is considered the very last resort for people who cannot find a better job this is a real constraint for a socially high-ranked researcher. Farmers have been looked down upon for decades. Depending on personalities, this gap in attitude often cannot be overcome by any training. Building of confidence and re-evaluation of indigenous knowledge are crucial elements to strengthen participation.

Crucial for any kind of participation is communication. Communication within the families, in particular between husband and wife, within the communities, and between farmers and extension workers has turned out to be weak. This causes considerable potential for conflicts and makes any development effort cumbersome unless they are specifically addressed. In addition to the weak communication structures in the families, different perspectives of men and women on certain issues further complicate communication. Another part of the learning process in the project showed that male domination in extension limits the attraction of extension for women. The tools and methods of how to address gender is culture specific and should be developed and adapted together with the people and available local experiences. There is no blueprint and the tools have to be situation-specific. However, one method should be applied universally: Give women the chance to prove their capabilities wherever possible (Hagmann *et al.*, 1997b). Women are mostly not as articulate in discussions as men. Often it requires simply a specific invitation to women, to provide their views and perspectives on the issues being discussed. Such encouragement allows them to participate actively in the discussions.

Farmers' individual trials

Similar to the participation process, farmer experimentation also proved to be a gradual process. Several factors were crucial as catalysts:

- The difference between trials and demonstrations had to be clarified. In contrast to the well-established demonstrations (where farmers are requested to follow the exact recommendations) adaptive trials that require farmers' own experimentation and can imply failures as well were a new concept to farmers and to extension staff. "Master farmers" in particular tend to be less innovative as they depend too much on the extension worker's recommendations. Moreover, they do not want other farmers to adopt the innovations they use as they would lose their privileges.
- Before initiating their own experiments, farmers had to gain self confidence in their abilities to experiment.
- A high level of participation had to be reached to overcome social/hierarchical constraints.
- Initial stimulation of ideas was crucial.
- Basic knowledge of methods of small-scale experimentation (same technical treatment for new and traditional techniques, e.g. planting date, fertilization etc.) was important to obtain reasonable comparisons between traditional techniques and new ideas.

Once the "fear of new things" that was identified by farmers as a stumbling block for experimentation had decreased through participatory methods and group discussions, all participating farmers started their own trials independent from the project and presented them proudly during joint evaluation tours. A total of 36 self-initiated trials on 16 farms were counted at the end of the second season in 1993 in one area. Several innovations (for example, on the use of implements, planting methods, relay cropping etc.) have been generated and the experimental spirit (accompanied by the number of farmer-initiated trials) has been increasing steadily after farmers had gained confidence and become more familiar with the approach. In the third season each of the farmers had at least three, some even up to 12 different trials mainly based on farmers' knowledge of their fields. The fear of new things was replaced by the spirit of trying that had taken off. A major factor in the spreading of farmer experimentation was the exchange of ideas among farmers during the workshops and in joint evaluations. Farmers' individual experiments revived the indigenous knowledge system as they were confident enough to talk about traditional knowledge and share it with fellow farmers and extensionists without fear of being ridiculed. The generally competitive spirit among farmers has supported this process as everybody tries to be innovative. The way farmers presented their findings proved that the new spirit has raised farmers' confidence, their morale and their identity as farmers; all the psychological factors farmers need to restore their capacities and to reduce apathy and resignation were noted. The joint forces of researchers and farmers enabled the development of a number of innovations through this approach within only four years, an achievement unthinkable with conventional research approaches.

Extension and the institutional context

Our experience showed that for effective spreading of innovations there is no alternative other than involving the whole community right from the start. Working with a few individual farmers alone does not encourage other community members to learn together. Specific socioorganizational interventions with, for instance, more active leadership training are needed. Such a comprehensive approach to participatory, community-based extension and innovation development was implemented and efforts were made to integrate this approach into the extension service. Such activities can no longer be limited to researchers. An ideal synergy exists if extension carries out the basic facilitation of community-based participatory extension and researchers join in this process when it comes to problems that require joint research. In this way it is ensured that the maximum benefit comes out of the research as their results are responding to farmers' questions and the research agenda.

In the agricultural extension service the participatory approach was favoured and supported by the officers. Field staff (older extension workers and extension supervisors in particular), however, were rather sceptical as they tended to follow a rigid top-down approach. Situations arose, where we encouraged farmer experimentation while the extension supervisor ordered that farmers should experiment only with the approval of the extension worker. In other cases, during evaluation tours, it was revealed that farmers' practical knowledge exceeded the mostly theoretical knowledge of extension workers. Such incidents make the extension workers insecure and they interpret this active farmer participation as a loss of respect and power, as technical knowledge is their only domain. For better trained staff it was easier to admit to not knowing everything as their wider background provides for enough respect anyway. The clash of the two approaches initially created reservations on the behalf of extension workers as they realized that a change is needed in authoritarian structures to put the farmer in the position of the main actor. Depending on their personalities, it was difficult to integrate them fully into the process in the early stages. Later, through an iterative training and coaching process extension workers increasingly appreciated the approach as it released them from "having to know it all".

Conclusions

With the conventional view, the task of developing improved tillage techniques appeared straightforward, however, in pursuing the goal of contributing to improved natural resource management, the close interaction with farmers showed us that the conventional approaches were often highly constrained and new ways of developing and spreading innovations had to be developed that were distant from the initial technical task.

This paper presented some methods and learning tools utilized in the process of experimentation-based participatory extension and research in our work. More tools are available and many more should be developed. They can be highly effective in enhancing farmers' self analysis and learning for land literacy and land husbandry. The tools, however, are only as good as the facilitation. In terms of diversity in technology, it appeared that once farmers understood the dynamics of the environment, they themselves came to apply an integrated land husbandry approach. The *kuturaya* model for participatory innovation development and extension has shown high potential to increase farmers' confidence and their ability to develop, test, and modify technologies. The activities have also shown to research and extension that it is possible to increase output in terms of innovations and spreading of techniques with this approach (Hagmann *et al.*, 1997a). On the other side of the coin, one has to admit that such a success requires considerable endurance, continuous stimulation, and the will to move things. In some communities the process has been very complicated as too many leadership conflicts dominated the whole scene. Therefore, in a large-scale implementation the success might not be uniform in all areas.

Three major differences between the old extension approach and the participatory approach need to be highlighted. Apparently farmers feel that now everybody can participate in the new approach (obviously not the case before). This was confirmed in other workshops that revealed that master farmer club members form an elite which does not want nonmembers to participate in innovations. The second major appreciation is dialogue and with it a sound explanation of processes rather than simply imposing techniques to be implemented. The third point is the encouragement of cooperation and sharing of knowledge.

Based on our experience a combination of quantitative and qualitative methods to evaluate the results of farmer experimentation and research is possible. Qualitative data and evaluations contributed more to the understanding of diversity and should be taken as the basis for quantification. Topics arising from qualitative assessment forced us to broaden the scope of the project as we were driven by farmers' perspectives of their farming systems with the relevant problems. Accordingly, our scope ranges from implementation development via social innovations to communication and extension strategies to be successful in soil and water conservation. Analysis of the variability of hard data led to the understanding of biophysical processes and to the conclusion that tillage and soil- and water-conservation techniques are highly site, soil, and farmer specific and therefore no blanket recommendations can be formulated. This was a basic insight that convinced extension officers of the need to explore new directions in extension in the field of natural resource management.

The institutionalization of this approach requires a paradigm shift and changes of attitude of all players involved, which is a long-term process and requires intensive training and follow-up operations. In our case, we managed to have a strong impact towards a change in the extension department. The implications of a bottom-up approach to be introduced in a strictly hierarchical system, however, are very complex in nature and touch policy and planning issues that need support and commitment from the top of the hierarchy to succeed.

The Agritex/GTZ Conservation Tillage project out of which this work emanated initially was a learning project that included iteratively its experiences in the project approach after every season. Due to this learning mode and the vision to make a difference at the farmers' level, the project managed to integrate research and extension effectively through farmer experimentation and facilitation of social processes. The learning process continues in the subsequent projects with regard to institutional reform to make these experiences and approaches accessible to many more smallholder farmers in Zimbabwe.

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