A Small Push Goes a Long Way: Farmers' Participation in Rainwater Harvesting Technology Development

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Abstract

Farmer participation in decision making at various phases of project implementation contributes very highly to project success. The Soil-Water Management Research Programme (SWMRP) has gained valuable experience in the involvement of farmer in all phases during the implementation of the programme. The programme used the following instruments to ensure farmer participation:

- *Socio-economic surveys including Participatory and Rapid Rural Appraisals.*
- *Farmer participation in on-farm experimentation.*
- *Participatory technology evaluation through workshops and seminars aimed at monitoring project performance and getting feedback from stakeholders.*

The process of farmer participation evolved over the duration of the project. Lessons learnt at the beginning were incorporated in the research process over time. Initially, the planning of the experiments did not fully allow for farmer participation. This shortcoming was later rectified, and more farmer participation was allowed. Among the achievements of the project is the construction of a water diversion canal worth about Tanzanian Shillings 1.28 million in Hedaru village, Same District. The structure is currently supplying water to about 45 hectares in the village. The programme contributed only 18 % of the total cost in terms of materials (6%) and technical support (12%). Farmer participation enabled mobilization of resources worth the remaining 82% of the total cost. The contributions were in the form of cash, labour, materials and decision making. This paper analyses the process of farmer participation in this programme and how it has influenced the performance of the programme. It is concluded that, with effective participation, minimum external support (small push) can result into substantial achievements.

Key words: Smallholder farmers, Participation, Rainwater harvesting, Adoption.

Introduction

Availability of improved technologies is an essential prerequisite for agricultural development. The development of these technologies requires an effective research approach. An effective research approach in this paper is defined as an approach that leads to the attainment of the intended research objectives that are relevant to beneficiaries. Farmer participation in the research process is one of the requirements for an effective approach.

Formal agricultural technology development in Tanzania is largely undertaken by various institutions such as the National Agricultural Research System (NARS), Sokoine University of Agriculture (SUA) and, to a limited extent, Non-Governmental Organizations. There are seven agricultural research institutes responsi-

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ble for undertaking research under the Ministry of Agriculture and Cooperatives. Each of the institutes has a mandate to undertake research relevant to a given agro-ecological zone. SUA has the mandate to undertake research in all research zones in the country (SUA, 1992) and is considered as the eighth research institute. Apart from agricultural technology development, there is also informal agricultural technology development. In this case farmers through their daily activities experiment and develop new innovations that are continuously used. Farmer experimentation is not a new phenomenon (Merrill-Sands, 1986; Rhodes and Bebbington, 1988; Richards, 1988;). Through this process, valuable information is generated and accumulated in the form of indigenous knowledge.

Approaches to technology development can be broadly classified into two categories: i) Top-down commodity approach (TCA) and ii) Farming Systems Approach (FSA). Up until the 1960s the top down commodity approach was the major approach. The main characteristics of this approach are:

- Researchers identify research problems,
- Stakeholders such as farmers are mere recipients of research results through technology transfer process,
- Research activities are organized by commodities and/or disciplines,
- Research is conducted on research stations, and
- Technology evaluation is based mainly on productivity.

This approach made great contributions to the development of agricultural science but very little impact to the smallholder farmers (Shaner *et al.*, 1982). The main limitations of the approach in addressing smallholder farmers include:

- Non consideration of farmers' circumstances in terms of objectives, environment, and socio-economic factors,
- Non consideration of interrelationships of various components of a production system, and
- Non use of existing local knowledge.

Given these limitations, a systems approach to technology development was developed. Farming systems approach was developed to complement the top-down commodity approach. The approach is based on the systems perspective. That is to view situations as whole and not as separate parts (FAO, 1993; Metrick, 1993). The main characteristics of the approach are:

- Problem identification is done by farmers and researchers,
- Technology testing is done both in farmers' fields and research stations,
- Research activities are undertaken by interdisciplinary teams,
- Stakeholders (farmers) are taken as partners in technology development, and
- Technologies are evaluated based on their wider performance in the system and assessed based on productivity, social, economic, and environmental compatibility.

This approach has made great contributions in changing the focus of research, it has considered small-holder farmers as the key actors in technology development. However, there has been criticisms to this approach arguing that the approach is still top-down (Tripp, 1989). Based on such criticisms more emphasis was given to participatory approaches to technology development (Chambers, 1994).

In recent years, there has been an explosion of participatory methods to technology development. The aim is to allow stakeholders (farmers) to express, present, and analyze their knowledge, and to share this with researchers (Chambers, 1994; Metrick, 1993). Participatory approaches include Rapid Rural Appraisal (RRA), Participatory Rural Appraisal (PRA), Participatory Assessment and Planning (PAP), Participatory Learning and Action (PLA), and Participatory Community Planning (PCP), to mention just a few. With participatory approaches the researchers' role is to widen the range of technologies available to the farmer by drawing on formal science. The farmer in turn provides specific local knowledge and in the final analysis he/she is the one who adapts technologies to his/her own circumstances. It is urgued that farmer participation as specified by FSA is not adequate (Mettrick, 1993). More tools and techniques are therefore used to ensure more participation of farmers.

The SWMRP used some of the approaches discussed above. The initial efforts of SWMRP in developing RWH technologies used TCA but later, FSA techniques were used to ensure farmer participation. These techniques include establishment of on-farm experiments, diagnosis and evaluation of research problems with farmers. The establishment of the Kifaru experimental site was based on FSA techniques. The objective of this paper is to analyze experiences of the SWMRP with farmer participation in RWH technology development.

Methods

The study area

The research work presented in this paper was conducted at three sites namely: Kisangara, Kifaru and Hedaru villages, located in the Western Pare Lowlands. The topography of the villages can be divided into three main zones: steep zone (slope >50%), gentle sloping zone (slope of 3-4%) and flat area (slope of 0-1%) (Rwehumbiza *et al.*, 1999). The three sites have similar farming systems (Lazaro *et al.*, 1999) which are i) Maize-Lablab Bean ii) Maize-Bean/Cowpea iii) Maize-Lablab Bean-Livestock iv) Livestock- Maize-Vegetables v) Maize-Vegetables and vi) Rice-Maize-Vegetables.

The study was carried out using the following techniques:

(i) Survey using participatory tools

The surveys were conducted in all the farming systems of the project area. The tools used include transect walks, participatory village mapping, ranking, constraint analysis, key informant survey and focus group interviews. These tools were used to promote a better understanding of the technologies developed.

Together with the surveys, workshops and seminars were organized. Various stakeholders were involved in these workshops, including farmers, policy makers, planners, extension workers, other researchers and NGOs. The main objective of these workshops and seminars was to exchange and gather ideas from farmers with the aim of developing rain water harvesting technologies that suit farmers' circumstances. These workshops have been instrumental in providing feedback to the project, fine-tuning of the technology and approach for research.

(ii) Field experiments

Kisangara site

Experiments at Kisangara site were fully managed by researchers. Farmers' participation was minimal. The main focus was demonstration of the various technologies to farmers. The experiments were on-station type and the planning and implementation followed basically the top down commodity approach. These focused on soil-water conservation and were designed to test the traditional farming techniques common in Kilimanjaro region. Five treatments namely, zero tillage (Kitan'gan'ga), flat cultivation with hand hoe, contour ridging, stone bunds, and live barriers of vetiver grass, were tested.

Farmers were involved by organising visits to the experimental sites and getting on the spot explanations from researchers. These were in the form of farmer open days on the experimental site. Farmers were allowed to observe the performance of different RWH techniques. This was useful in creating awareness of farmers on the available techniques for RWH.

Kifaru site

The method adopted at Kifaru site allowed for more farmer participation. Unlike the Kisangara site, the Kifaru experimental site was an on-farm type of experiment. Contracts were made with farmers to use part of their land for experiments. This allowed for closer viewing of the plots by farmers in the village, without depending on organised visits. The site however, was still managed by researchers.

The technology tested was water diversion from gullies using simple earthen waterways and distribution canals made from burnt bricks. Three treatments, Flat Cultivation without run on (FC), Flat cultivation with water conservation but without RWH, and Flat cultivation with water conservation with RWH from external catchment were tested.

Hedaru site

The Hedaru village site was established following a request from a few farmers who participated in the organized visits to the RWH experimental sites. The experiments on this site were on-farm farmer-managed type. Farmers identified their own problem, the solution to the problem and participated in the planning and design of the technology. The treatment used was an adaptation of simple diversion of water from a gully.

(iii) Technology Evaluation

Instead of using a demonstration approach alone, farmers' technology evaluation was included in all sites. A sample of 20 and 10 farmers, including farmers from Hedaru village, were selected to carry out the evaluation (Hatibu *et al.*, 1999). A card system was used in ranking the plots with different treatments. For the Kisangara site, cards were numbered from 1 to 5 where number 1 indicated best performing plot, number 2-second best up to 5 that was the least. This is because there were five treatments to compare. At Kifaru site, there were only three treatments to compare therefore the cards were numbered from 1 to 3 where number 1 indicated best performing plot, number 2 second best and 3 the least. In both cases farmers set their own evaluation criteria.

Results and Discussion

Problem analysis and technology identification by farmers

Based on the surveys, seminars and workshops, one of the most critical factors limiting agricultural production was identified to be low and erratic distribution of rainfall. Further analysis of the problem and potential solution, showed that RWH was one of the promising interventions in the area. The recommendations from the workshops and seminars further showed that provision of supplementary water and concentration of rainwater were the most acceptable solutions for agricultural production in the study area. The challenge was therefore to develop a technology acceptable to farmers in terms of design and cost. Based on these findings the treatments for the Kifaru site were selected and tested on farm.

Technology evaluation by farmers

The results of the farmer evaluation at both Kisangara and Kifaru sites were not very different (Table 1). The criteria for evaluation of treatments were common in both sites and included the size of the maize ears and the stem. These can be considered as direct proxies for the yield indicator. The density of maize plants, the height and general performance of plants were all indicators of the performance of the crops under different treatments. The colour of the leaves was an indicator for moisture stress to the crops. For crops with moisture stress the leaves tend to dry and change colour to yellowish. Green colour indicates that the plants have enough moisture.

The results of the ranking at Kisangara and Kifaru sites are presented in Table 2 and Table 3 respectively. Table 2 shows that contour ridging is ranked first, 67% of the times the ranking was done. While zero tillage which is the common farmer practice was ranked fifth, 56% of the times. That is, based on farmers' criteria, maize crop under contour ridging was performing better compared to other practices.

Table 1. Farmers Criteria for Technology Evaluation

Kisangara	Kifaru
• The size of maize ears	• The size of maize ears
• The size of the stem	• The size of the stem
• The density of maize plants	• The colour of the leaves and stem (green or dry)
• The height of maize plants	• The general performance of the plants.

Table 2 Farmer Evaluation of RainWater Harvesting at Kisangara Site

	Treatment/				
Rank	Zero Tillage	Flat Cultivation	Live Barriers	Contour Ridging	Stone Bunding
1	0	0	3(33%)	6(67%)	0
2	1(11%)	1(11%)	2(22%)	2(22%)	3(33%)
3	2(22%)	3(33%)	3(33%)	0	1(11%)
4	1(11%)	4(44%)	1(11%)	1(11%)	2(22%)
5	5(56%)	1(11%)	0	0	3(33%)
Total	9(100)	9(100)	9(100)	9(100)	9(100)

The results at Kifaru site show that all the plots (100%) with added run on from the gully were ranked first. Whereas 61% of all the plots with SWC only were ranked second (Table 3), the results from the two sites show that farmers were convinced that RWH improves crop performance. This was the basis for farmers' adoption of the proposed RWH technology. The fact that the experiments at Kifaru site were conducted on farmers' fields, more farmers were able to observe the performance of the technology. The performance of maize in plots with RWH was better than plots without RWH. This influenced the uptake of the technology even beyond the experimental site (Hedaru).. Farmers were also attracted by the simplicity of the design. Unlike the Kisangara site, the design was simple enough to encourage farmers to test the technology on their own. As a result, several farmers started to divert runoff from gullies into their fields. When the field experiments were started in 1997 only one farmer was using RWH (diverted sheet/rill run-off) in his crop fields. By 1999 there were twelve farmers who copied the system of diverting gully runoff. For these few practising farmers substantial yield increase was observed. The average maize grain yield increased from 2,918.1 $kgha^{-1}$ on fields without RWH to 4,101.7 $kgha^{-1}$ on fields with RWH (Hatibu *et. al.*, 1999). This is a 41% increase in yield of maize compared to maize grown without RWH.

Experience from the Kisangara site suggests that farmers' participation in evaluating research experiments can guide researchers in designing technology. However, it is important to involve them from designing to implementation, as was the case for the Kifaru site.

Table 3: Farmer Evaluation of Rain Water Harvesting At Kifaru Site

Rank	Treatment/plots		
	Flat cultivation	With SWC only	With SWC and RWH
1	0	0	18 (100%)
2	7(39%)	11(61%)	0
3	11(61%)	7(39%)	0
Total	18	18	18

Challenges to RWH technology adoption

According to farmers' observations, maize crop failure occurs when only one rainstorm would be needed to rescue the situation. The SWMRP has coined this situation as a 'one rainfall syndrome'.. However, farmers still observe that, while crop fields suffer from water stress there is always plenty of runoff water flowing through gullies and streams (such as Mtowashi in Hedaru), which passes across their crop fields. Farmers felt that using the water from such streams and gullies can solve the problem of water stress in crops (particularly maize). The results of the group interviews showed that farmers were faced with two main challenges to adoption of RWH: i) Technical and ii) Economic

- Technical challenges include:
  - Design and construction of diversion structures
  - Based on farmers' knowledge some gullies were too deep to tap the water at points suitable for water diversion (sometimes up to 2.5m deep).
  - Control of soil erosion in the cropped fields after water diversion
  - In field water management and water application schedules
- Economic challenge include:
  - Capital for the design and construction of the diversion structures.

Farmers believed that the design and construction cost of RWH structures (a diversion weir and canal) are beyond their economic capability.

Support (small push) to Farmers' adoption of RWH Technology

The outcome of farmer participation in technology evaluation is illustrated by the case study at Hedaru village. Given the challenges identified by farmers, a plan was designed to support farmers in RWH adoption at Hedaru village. At this site farmers participated in problem identification, planning and implementation of the experiments. As a result of this, external support required was minimized. Beneficiary farmers provided 82% of the total value of the resources required for constructing RWH structures. External support was offered in terms of industrial materials such as cement, and technical support (in planning, designing and supervision of construction). This support was valued at 6% and 12% respectively, of the total value of the required resources. The construction of structures was completed within a very short time, such that about 110 ha of maize were supplied with supplementary water from Mtowashi gully during the 1999 cropping season. The designed structure has the capacity of supplying water to about 250 ha during the months of May and June (the critical months for moisture stress in maize). The results of a participatory evaluation showed that maize grown under RWH performed better than that grown without RWH. Quantification of these findings indicated that maize yields in plots with RWH yielded more than plots without RWH. On average the yield for plots with and without RWH were 5.4 tons per hectare and 1.7 tons per hectare respectively.

Conclusion

The process of farmer participation in Soil and Water Management Research Program (SWMRP) evolved over the project period. With farmer participation the project has demonstrated that it requires relatively less external support (small push) for them (farmers) to contribute substantially towards technology development and adoption. There are three main lessons on farmer participation learned from this project. These are:

(i) Farmers have a good knowledge of potential solutions to their agricultural production constraints.

(ii) Often times farmers lack the means to solve their constraints

(iii) Farmers need minimum external support to overcome these constraints

The experience of SWMRP in farmer participation shows that, there are tangible benefits for involving farmers in technology development. The main benefits are:

- Through participation in decision-making, farmers contributed in technology development. In this project the main areas where their contribution was notable are in determining appropriate sites for generating and collecting runoff for RWH, and contribution of resources, including land, labour and materials (sand stones water) for experimental purposes.
- Farmer's involvement in on-farm experiments shortened the time for experimentation. Farmers in Hedaru and Kifaru rapidly started practicing RWH simply by copying from neighbours who participated in the project experiments.
- Farmers contributed a substantial amount of resources for research. This reduced the cost of research substantially.
- Instantaneous adoption of RWH. This is because the technology was refined with the farmers.
- Partnership with stakeholders was developed. The main partnerships developed are between farmers, extension workers and researchers. Through this partnership each partner contributed the relevant expertise, which made it possible for accumulation of valuable knowledge necessary for technology development.

References

Chambers, R. 1994. Participatory Rural Appraisal (PRA): analysis of experience, *World Development*, 22 (9):1253-1268.

FAO. 1993. Guidelines for the conduct of training course in farming systems development. FAO, Rome

Hatibu N., H.F. Mahoo, F.B.R Rwehumbiza and S.R. Kishebuka. 1999. Participatory Evaluation of RWH Practices and Trials in the Pare Lowlands. Soil-Water Management Research Programme, Sokoine University of Agriculture, Morogoro. 23pp

Hatibu, N., J.W. Gowing O.B. Mzirai and H.F. Mahoo. 1999. Performance of Maize under Micro-Catchment Rainwater Harvesting in Western Pare Lowlands and Morogoro, Tanzania, *Tanzania J. Agric. Sc.* 2(2):193-204

Lazaro E.A, N. Hatibu, H.F. Mahoo and F.B.R. Rwehumbiza. 1999. Adoption of Rainwater Harvesting Techniques in the Farming Systems of Western Pare Lowlands. Soil-Water Management Research Programme, Sokoine University of Agriculture, Morogoro. 37 pp

Merrill-Sands, D. 1986. The technology applications gap: Overcoming Constraints to small-farm development. FAO, Rome.

Metrick, H. 1993. Development Oriented Research in Agriculture: An ICRA textbook, ICRA, Wageningen, The Netherlands. pp.291

Rhodes, R and A. Bebbington. 1988. Farmers who experiment: an untapped resource for agricultural research and development? International Potato Center (CIP), Lima.

Richards, P. 1988. Experimenting Farmers and Agricultural Research. Paper prepared for ILEA Workshop on Participatory Technology Development, ILEA, Leusden.

Rwehumbiza F.B., N. Hatibu, and S.R Kishebuka. 1999. Evaluation of contour barriers for soil and water conservation in Western Pare Low Lands, Tanzania. Tanzania J. Agric. Sc. 2(2): 179-189

Shaner, W.W., P.F. Philipp and W.R. Schmehl. 1982. *Farming Systems Research and Development: Guidelines for Developing countries,* West-View Press, Boulder, Colorado.

SUA 1992. SUA Research Policy Priorities and Guidelines. Directorate of Research and Post Graduate Studies. Sokoine University of Agriculture, Morogoro, Tanzania.

Tripp, R. 1989. Farmer participation in agricultural research: New directions or old problems? Discussion Paper 256, February1989, IDS, Brighton, UK.