Managing Africa's Soils No. 5

Experiences of farmer participation in soil fertility research in southern Zimbabwe

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About the authors

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About NUTNET

NUTNET stands for *Networking on soil fertility management: improving soil fertility in Africa-Nutrient networks & stakeholder perceptions*. It was drawn up with the primary aim of bringing together the following three research programmes:

- *The dynamics of soil fertility management in savannah Africa* co-ordinated by IIED and IDS/UK;
- *Spatial and temporal variation of soil nutrient stocks and management in sub-Saharan Africa systems* (VARINUTS) co-ordinated by SC/DLO the Netherlands;
- *Potentials of low-external input and sustainable agriculture to attain productive and sustainable land use in Kenya and Uganda* (LEINUTS) co-ordinated by LEI/DLO, the Netherlands.

NUTNET is a partnership of 15 organisations coming from 6 African and 2 European countries. They are INERA, Burkina Faso; SOS Sahel, Ethiopia; KARI, KIOF & ETC East Africa, Kenya; IER, Mali; Environment Alert & Makerere University, Uganda; IES, Zimbabwe; IIED & IDS, United Kingdom; AB/DLO, LEI/DLO, SC/DLO, ETC & KIT, The Netherlands. NUTNET has been made possible through generous funding from the Netherlands Development Agency (NEDA), Ministry of Foreign Affairs, the Netherlands.

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Summary

This paper documents the Farming Systems Research Unit (FSRU) experiences with participatory research on soil fertility in Chivi, southern Zimbabwe. In particular, it discusses the empowerment processes used to convert farmers from mere spectators in on-farm research to full participants.

Since 1992, FSRU has been involved in 'farmer participatory trials' in which farmers select the objectives and manage the experiments. The objective of these experiments is not to obtain results which are statistically valid, but results that are satisfactory within the context of a particular production system. The trials are conducted with 'farmers' research groups'. Working through groups facilitates information sharing and the spread of innovations. They also build farmers' confidence which the latter need when evaluating trials and to get their problems on the researchers' agenda. FSRU and the groups also organise exposure visits, farmer cross visits, field days and workshops.

Participatory trials were set up on the reclamation of sodic soils using gypsum, termitaria and drainage lines. Other trials dealt with improving sandy and gravelly soils involving treatments with manure, leaf litter, anthill and ashes. A total of 120 farmer experiments was conducted between 1993 and 1997. In addition, researchers carried out soil sampling, measured fertility inputs and harvested outputs at plot level. The results contribute some quantitative insights to the joint investigation with farmers.

French summary

Expériences de la participation d'agriculteurs aux recherches sur la fertilité des sols au Sud-Zimbabwe

Ce document relate les expériences menées par l'Unité de Recherche sur les Systèmes Agricoles (*Farming Systems Research Unit : FSRU*) en matière de recherche participative sur la fertilité des sols, à Chivi au Sud-Zimbabwe. En particulier, il traite des processus de délégation de pouvoir employés pour convertir les agriculteurs - de simples spectateurs de la recherche sur place - en participants actifs.

Chivi se trouve dans la partie centrale du Sud-Zimbabwe. Les précipitations y sont faibles et irrégulières, avec une moyenne de 570 mm. Les sols sont, en général, pauvres et sablonneux bien qu'il y ait aussi quelques petites zones de sols eutrophiques plus riches. Les agriculteurs font des apports d'éléments nutritifs sous forme de fumier de bétail, litières de feuilles, termitières, compost, ordure domestiques et engrais inorganiques.

Dans les années 1980, au Zimbabwe, les chercheurs ont reconnu l'importance de tester les nouvelles technologies dans les conditions rencontrées par les agriculteurs, avant de les proposer aux services de vulgarisation chargés de les diffuser. En 1982, ils créèrent une équipe de recherche sur les systèmes agricoles. Son mandat était de mener des recherches pluridisciplinaires sur des technologies adaptées aux petits exploitants agricoles. De nouvelles technologies furent conçues à partir d'une série d'études expérimentales et de tests d'adaptation des technologies issues des stations de recherche. Des vulgarisateurs en agriculture avaient pour tâche de diffuser les innovations testées.

En 1992, l'équipe de la FSRU décida de réviser ce modèle après que des évaluations d'impact aient révélé que les taux d'adoption de ces innovations étaient faibles. Divers défauts sont alors apparus. L'un des problèmes venait du rôle trop limité des agriculteurs dans le processus de recherche. Les chercheurs contrôlaient et géraient les essais expérimentaux sur les terres de l'exploitant. Les concepts étaient souvent complexes, interdisant ainsi la participation des agriculteurs. Ceux-ci ne comprenaient pas souvent les objectifs poursuivis par les recherches et considéraient que ces essais n'étaient une occasion d'apprendre que pour les chercheurs. Une autre raison du changement était la participation de la FSRU à une étude des décisions prises par les agriculteurs dans des conditions de risque et d'incertitude. Les résultats révélaient une large palette de variabilité spatiale et temporelle à Chivi, provenant de la diversité et de la complexité des milieux dans lesquels les agriculteurs avaient à travailler.

La FSRU décida donc de mettre au point une nouvelle approche en matière de recherche. L'objectif consistait à associer les agriculteurs à toutes les étapes de la recherche et de la production de technologie. La FSRU engagea des "essais de participation des agriculteurs" au cours desquels ceux-ci choisissaient les objectifs et conduisaient les expériences. Le but de ces expériences n'était pas d'obtenir des résultats statistiquement valides mais des résultats satisfaisants dans le contexte d'un système particulier de production.

Un autre changement de méthodologie porte sur le fait que, désormais, on travaille avec des "groupes de recherche agricole". Le travail en groupe facilite l'échange de l'information et la diffusion des innovations. Il renforce également la confiance des exploitants dont ils ont ensuite besoin quand il s'agit d'évaluer les essais et de mettre leurs problèmes à l'ordre du jour des chercheurs. Ces groupes regroupent généralement des voisins. Beaucoup de femmes en deviennent membres. La participation des femmes aux activités de recherche s'est avérée plus stable que celle des hommes.

Les essais participatifs étaient basés sur l'amendement de sols sodiques à partir de gypse, de termitières et de lignes de drainage. D'autres essais s'attachaient à améliorer des sols sablonneux et graveleux par des apports de fumier, de litières de feuilles, de termitières et de cendre. Au total, 120 expériences auront été conduites auprès des agriculteurs entre 1993 et 1997.

Parallèlement à ces expériences, les chercheurs prélevaient des échantillons de sol, mesuraient les intrants de fertilité et les récoltes au niveau des parcelles, pour ajouter des mesures quantitatives aux investigations effectuées en commun avec les agriculteurs.

Les chercheurs appuyaient également les visites de découverte (stations de recherche, projets, exploitants novateurs) ailleurs dans la province, afin d'élargir le champ des options de recherche ouvertes aux groupes d'agriculteurs. Les chercheurs fournissaient aussi le matériel nécessaire aux essais et au suivi de ces derniers.

La FSRU est très satisfaite de cette approche. Néanmoins, l'assistance aux groupes d'agriculteurs prend du temps et coûte de l'argent. Les visites de découverte, les rencontres entre agriculteurs, les journées passées sur le terrain et les ateliers de travail sont des activités essentielles qui ont aussi besoin d'un financement.

1 Introduction

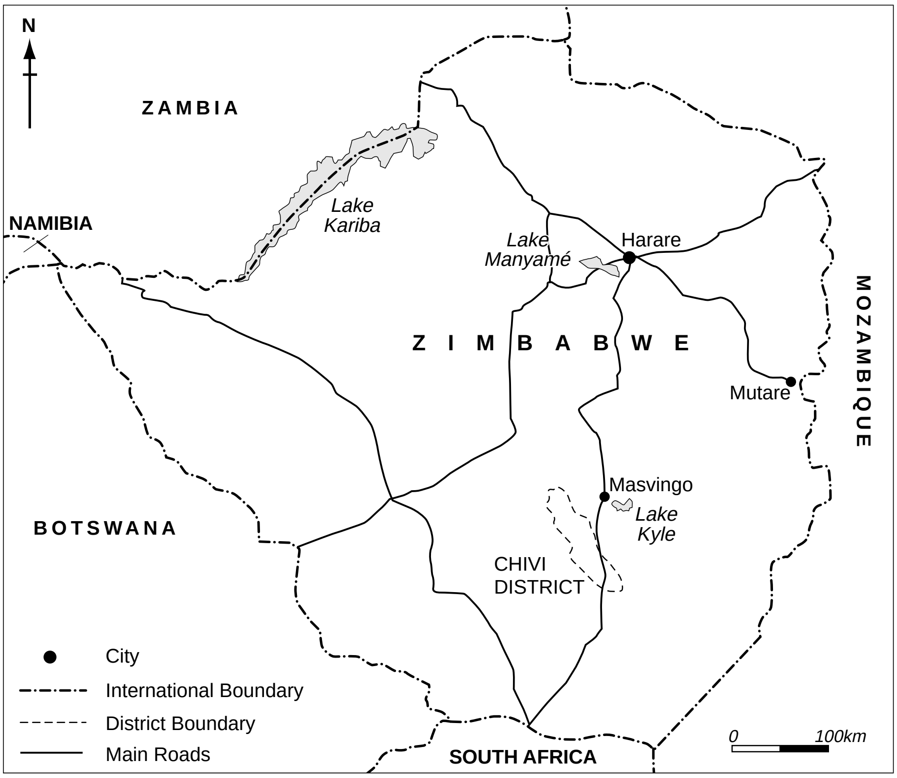
Most small holder farmers in Chivi Communal area, southern Zimbabwe have many years of negative experience with top-down approaches used by agricultural research and extension. Farmers have had no option but to go underground with their derided traditional knowledge and practices. However, over time researchers have begun to acknowledge the importance of testing out technologies developed on-station under farmers' conditions before proposing these to the extension services for dissemination. Some have even gone one step further and recognised the importance of learning from farmers' practices and involving farmers in research.

This paper documents and examines the experience of the Chivi-based Farming Systems Research team from 5 years from 1992 to 1997, involving farmers in participatory research on soil fertility. In particular, it discusses the empowerment processes used to convert farmers from being mere spectators in on-farm research to full participants. Over this period, farmers have become co-researchers, co-analysts and resource persons. They analyse constraints faced by small scale farmers and plan appropriate research and technology development. They organise field days, workshops and feedback meetings.

2 The study area

Chivi Communal Area is located in Masvingo Province in the South-Central part of Zimbabwe (see Figure 1). Rainfall is low, erratic and poorly distributed. The average rainfall measured at Chivi office is of 570 mm, but it has ranged from 229 mm to 1191mm per year. Crop failure due to drought is common. According to farmers the probability of a good season is one year in five. Between 1982 and 1993, the Chivi district received a total of 56,516 tonnes of grain for drought relief, which is the highest amount for Masvingo Province as a whole (Department of Social Welfare, 1993).

Figure 1 Map of Zimbabwe and study area



Poor soil fertility is another recurrent complaint. Soils are mostly poor sands of granite derivation in 70% of the area. There are also with smaller areas of more fertile eutrophic soils. Extracts from the reports of the field-based FSRU team show that Chivi farmers identify seasonal uncertainty, droughts, waterlogging, pests and diseases as their main difficulties (Box 1).

Box 1: The challenges of Farming in Chivi Communal area.

16 April 1988: Chivi South and Central received 1000mm and 700mm of rainfall respectively. Problems are rampant, such as water logging, green locusts, quelea birds, ergot on millets, cobrot on maize and wire worm on groundnuts.

15 March 1990: Chivi South suffered badly from water logging at the start of the rainy season in January which was followed by a severe mid-season drought in month in February.

15 May 1991: Widespread drought wiped out maize: very low yields were expected from small grains. Although 600mm of rain was recorded in Chivi South, it was poorly distributed and coming in short intensive downpours, resulting in extensive erosion and poor infiltration into the soil.

15 February 1992: The worst drought since the arrival of the Farming Systems Research Unit team in Chivi has virtually wiped out all crops. Livestock was dying in large numbers.

15 January 1993: There was an 'outbreak of mice' everywhere, devouring planted crop seeds, severely affecting crop establishment. Webworm was killing germinated millet plants.

Source: Field reports, Chivi FSRU team

3 Towards greater farmer involvement in the research process

The creation of the Farming Systems Research Unit

The Farming Systems Research Unit was created in 1982, to conduct multi-disciplinary research on technologies appropriate to small-scale farmers. The CIMMYT model of farming systems research (Collinson, 1982) was adopted. Researchers had the mandate to develop new technologies through a sequence of diagnostic studies and adaptive testing of 'off-the-shelf' technologies provided by research stations. Diffusion of tested innovations was the task of agricultural extension workers.

Shortcomings of the CIMMYT model

In 1992 the FSRU team reviewed the CIMMYTCimmyt model after an evaluation had revealed poor farmer adoption of technologies despite nearly ten years of research work in the area. The model was found to be inappropriate in many respects. It was premised on the concept of relatively homogenous recommendation domains. Problems within such domains were diagnosed by researchers who intervened by way of testing what they considered 'best-bet' solutions derived from station-based research results. Researchers controlled and managed standardised experimental trials on farmers' fields. Designs were often complex, effectively precluding effective farmer participation. This approach limited the role of farmers in the research process and continued to maintain a distance between farmers and researchers. Farmers often misunderstood research objectives and viewed the trial sites as places of learning for researchers only. Farmers' involvement in this type of research was limited to providing the answersing for researchers' diagnostic questionnaires. They gave land for experimental plots, ploughed researchers' plots and attended field days organised and run by researchers.

The CIMMYT model advocates a long time frame for 'technology transfer'. The steps proceed fromdiagnosis to on-farm trials, demonstration and extension, and farmers must therefore wait for years before they can use results from research conducted in their own fields. The model was also rather extractive of local knowledge and mainly geared to producing research papers for the scientific community. This evaluation of the CIMMYT model as applied in Zimbabwe persuaded FSRU researchers to opt for a new direction and approach to research which would increase the involvement of farmers in the research process. In the following sections we would like to share some of our reflections on the process of moving towards greater farmer involvement in on-farm research.

New directions

Another major impetus to opt for a new direction to research with farmers was the FSRU team's experience in conducting the study of 'Risk and Uncertainty', carried out between 1991 and 1993 (see Scoones et al., 1996). This study assessed farmer decision-making under conditions of greater uncertainty, and it revealed the huge range of spatial and temporal variability in the area. Understanding farmers' responses required an appreciation of the diversity and complexity of the their environment. It was therefore clear that farmers' full involvement in the research process was critically important.

The FSRU team started a series of farmer-initiated and farmer-led trials in November 1993. The objectives of the participatory trials are selected by farmers. Key constraint identified by farmers were the availability of hybrid maize seed and low soil fertility. Farmers therefore decided to test open pollinated maize varieties while at the same time also assessing the effectiveness of a range of low cost, locally available sources of organic fertilisers by farmers.

FSRU also decided to explore further the issue of soil fertility and identify farmers' priorities, perceptions and problems related to soil fertility management (FSRU, 1993; Mavedzenge et al., 1995; FSRU, 1996). The research uncovered a vast array of different soil fertility practices by farmers (see Box 2).

Farmers had experience of adding nutrients through the application of kraal manure, leaf litter, termitaria, compost, household waste, and inorganic fertilisers. They practised winter ploughing to conserve soil-moisture. They knew for each source of nutrients which crops and soils responded best, the period of residual effect, application methods, amounts to be used and the costs. They also had ideas on the timing of applications in view of the temporal and spatial variability. Farmers mentioned the advantages and disadvantages of each type of fertiliser and made suggestions for how to enhance their efficiencies.

Box 2. Nutrient cycling and existing farmer practices

Organic outputs:	Kraal manure, compost, leaf litter, Termitaria
Inorganic inputs:	Fertiliser (basal, top dressing)
Priority crops for fertilisation:	Maize, sorghum, groundnuts

Practices:

a) Increasing organic quantities by adding different types of organic material from Kraals and compost

b) Using well decomposed organic inputs to increase quality and reduce the risk of crop burn if rains are inadequate

c) Applying inorganic fertilisers only after crop emergence as a 'hedge' against early season droughts

d) Targeted input application of inputs to maximise the efficient use of scarce resources e.g. placing in furrow or planting holes

e) Spot application of inputs to poorer niches of fields and to needy plants

Source: Mavedzenge et al., 1995

This research laid the ground for an extensive programme of farmer-oriented action research to improve soil fertility. It also helped to identify the wider social and economic context within which soil fertility management was carried out. Participatory trials were later set up on the to reclamation of sodic soils using gypsum, anthill (termitaria) and drainage lines. Trials to improve the fertility of sandy and gravelly soils involved treatments with manure, leaf litter, anthill and ashes. A total of 120 farmer experiments was conducted between 1993 and 1997 (see also Box 3).

Farmers also drew bio-resource flow diagrams of their current farming systems, from which farmers and researchers identified possible areas for reducing nutrient losses and increasing nutrient use efficiencies. This was the basis for the development of further, scenarios to improve their management of nutrient cycles on their farms (see Fig 2 and 3 on page 9 and 10).

These farmers then launched trials to monitor residual fertility of different forms of organic nutrient inputs on open pollinated maize varieties. Inorganic fertilisers were included in the trials to compare costs and results with organic resources which usually have a residual effect over a period of two to three years (see Box 4). In addition, researchers carried out soil sampling, and measured fertility inputs and harvested outputs at plot level to contribute more detailed, quantitative insights to the joint investigation.

Box 3. Types of farmer experiments from 1993 to 1997

Type/number of experiments	Seasons 93/94	94/95	95/96	96/97
Open pollinated maize x fertility	15	16	28	22
Groundnuts x fertility	2	2	5	5
Bambara nuts x fertility	2	2	4	2
Reclamation of sodic soils	1	2	2	1
Pearl millet variety x fertility	1	0	0	0
Sunflower variety x fertility	0	0	2	4
Residual fertility trials	0	0	0	2

Some examples of experimental treatments:

Maize
1) No organic or inorganic fertiliser applied
2) Cattle manure only applied - farmer level
3) Fertiliser, basal and top dressing applied - farmer level

Groundnuts or Bambara nuts
1) Leaf litter applied - farmer level
2) Gypsum (200 kg/ha) - researcher level
3) Gypsum + Ssingle Ssuper Pphosphate (200 kg/ha) - researcher level
4) Cattle manure applied - farmer level
5) Anthill applied - farmer level

Sodic soil reclamation
1) Sand (river sand) only applied
2) No organic or inorganic fertiliser applied
3) River sand and anthill applied - farmer level
4) Trenches + Gypsum
5) Trenches only (trenches 1m wide, 30 cm30cm deep)

Residual fertility with open pollinated maize as test crop
1) Cattle manure - farmer level to last 3 seasons
2) Anthill - farmer level to last 3 seasons
3) Compost - farmer level to last 3 seasons
4) Inorganic fertiliser - farmer level applied every season

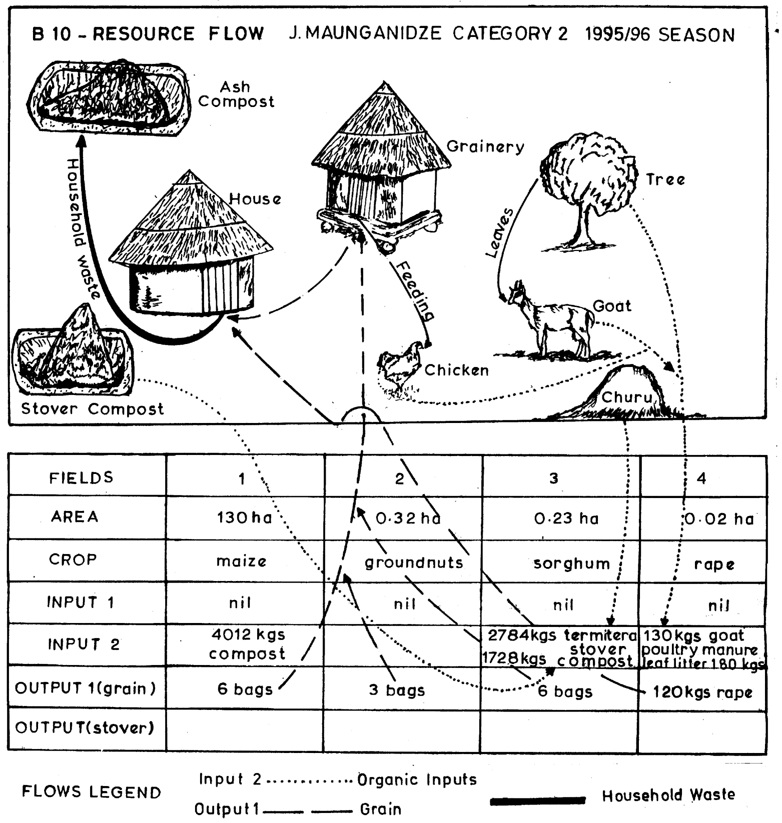
Box 4. Trial results of a farmers group

The Maregere farmers' group opted for a maize trail. They compared four varieties and three soil fertility treatments. The results for the season 1995/96 are presented in Table 1. The results indicate that the application of manure, for which the quantity applied has not been given, does not improve yields. The use of inorganic fertiliser does improve yields, but again, the quantities applied are unknown.

Table 1. Maize yields for 4 maize varieties and three soil fertility management treatments on sandy soils (tons/ha) for 1995/96

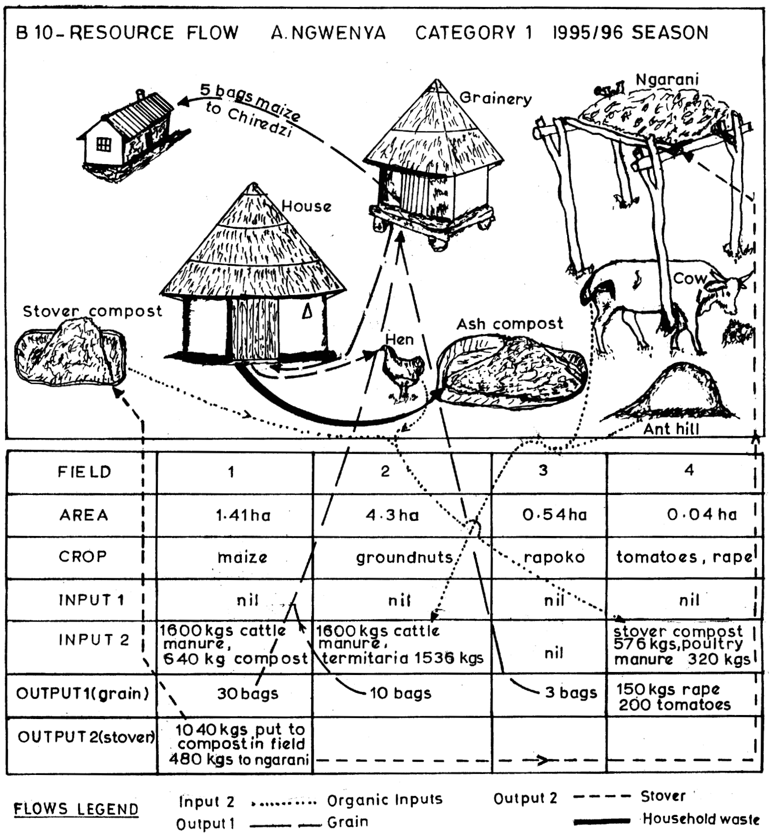
Maize Genotype	**No fertiliser**	**Manure**	**Fertiliser only**
NTS 88	1.56	1.11	2.00
NTS 9405	0.65	0.40	2.39
NTS 9406	0.67	1.29	0.79
NTS 9407	0.44	0,36	0.96
Overall mean	0.83	0.79	1.54

Figure 2. Resource flow diagram of J. Maunganidze for the season



Field	1		2		3		4	
	N	P	N	P	N	P	N	P
Input 1 (inorganic fert.)	0	0	0	0	0	0	0	0
Input 2 (organic fert.)	20	4	25	8	0	0	9	4
Total input	**20**	**4**	**25**	**8**	**0**	**0**	**9**	**4**
Output 1 (grain crop produced	42	8	35	18	0.7	0.1	4	2
Output 2 (stover taken or grazed	10	1	0	0	0	0	0	2
Total output	**52**	**9**	**35**	**18**	**0.7**	**0.1**	**4**	**2**
Nutrient balance/ field	-32	-5	-10	-10	-0.7	-0.1	+5	+2
Nutrient balance/ hectare	-22	-3	-2	-2	-2	-0.3	+126	+46

Figure 3. Resource flow diagram of A. Ngwenya for the season 1995/1996



Field	1		2		3		4	
	N	P	N	P	N	P	N	P
Input 1 (inorganic fert.)	0	0	0	0	0	0	0	0
Input 2 (organic fert.)	24	8	0	0	27	12	5	1
Total input	**24**	**8**	**0**	**0**	**27**	**12**	**5**	**1**
Output 1 (grain crop produced	8	2	11	0.5	2	0.2	1	0.1
Output 2 (stover taken or grazed	0	0	0	0	0	0	0	0
Total output	**8**	**2**	**11**	**0.5**	**2**	**0.2**	**1**	**0.1**
Nutrient balance/ field	+16	+6	-11	-0.5	+25	+11.8	+4	+0.9
Nutrient balance/ hectare	+12	+5	-33	-2	+11	+50	+17	+40

4 Working with farmers in participatory research

Importance of groups

In the past, researchers selected some individual farmers in each recommendation domain. These 'target' farmers were often reluctant to share information with other farmers and distanced themselves from their colleagues. One of the changes in methodology after 1992 has been that researchers started working with farmers' research groups.

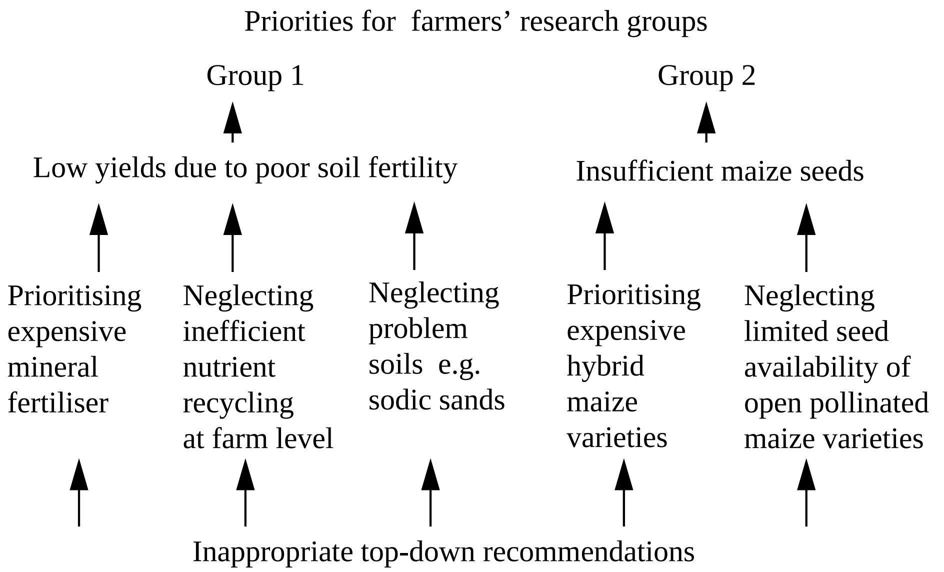
Many observers have noted the advantages of working with groups of farmers in agricultural research. Groups improve dialogue amongst farmers and with researchers and facilitate the organisation of field days. They also result in a more efficient use of scarce research resources (e.g. Norman et al., 1988). Working in groups can also build farmer' collective confidence which they need when evaluating research trials and to get their needs taken into account by researchers. Groups also facilitate the reaching of consensus positions.

Chivi farmers identified the sharing of ideas and labour as important advantages to working in groups (Mudhara et al., 1996). Working in groups facilitates the exchange of information and hands-on experience at their group research sites. The wider adoption in Chivi of open pollinated maize varieties, high yielding varieties of groundnuts and bambara nuts, of sodic soil reclamation techniques, and the revival of interest in the use of indigenous soil fertility resources, has mainly been due to the efforts of farmers' research groups. Groups thus create a multiplier effect which assists the spread of relevant improved technologies.

Group formation

In Chivi, farmer groups were formed voluntarily by those who wanted to solve a particular problem. Problems that motivated farmers were for example yield reductions due to low levels of soil fertility and lack of maize seeds (Figure 4).

Figure 4. Entry points for farmer research groups



Groups are generally composed of neighbours, who are often related and have known each other for a long time. Mean group size hovered between 7.0 and 8.5 farmers over the period from 1993 to 1997, and included a high proportion of women (Table 2). Women's membership and involvement in research activities have proven to be more stable than that of men compared to men.

Table 2. Farmer group composition 1993 - 1997

Composition	1993/94	94/95	95/96	96/97
Number of groups	15	22	24	20
Women	66	71	103	108
Men	61	85	66	46
Mean group size	8.5	7.1	7.0	7.7

New groups were formed almost every season between 1993 and 1996. Four groups, however, did not implement trials in 1997. One group had reached consensus after 3 seasons of tests on how to treat sodic soils. The other three experienced problems with internal organisation and co-operation which delayed trial implementation: planting for that season then became impossible up to the once water logging had set in.

Farmers versus researchers: dealing with different objectives

Farming systems researchers used to avoid spatial heterogeneity when selecting a site for a trial. However, farmers often decide to locate the experiment where they are experiencing the problem. They usually vary the size of the experimental plot according to the number of options to be tested, labour availability, and the required inputs. They are also inclined to adjust the trials and treatments over the years as they want to respond to new insights or emerging problems (Mudhara et al., 1996). Trial size and lay-out is likely to vary from farmer to farmer, given that they do not face the same pressures or have similar endowments. The evaluation of a trial thus has to be site specific, taking into account a farmer's particular constraints and opportunities.

However, farmers' criteria for site selection and the adjustments they make to treatments and lay-out of the trial may create a conflict of interest between researchers and farmers. Researchers will argue that these variations and adjustments reduce the confidence which can be placed in the results. Similarly, as was seen earlier (see table 1 in box 4) many of the trials had not involved careful measurement of the inputs used. However, farmers will argue that their aim is to solve problems which are often highly site specific and dynamic. In their view it is therefore appropriate to adapt the design and treatments between one season and the next and even within the season - e.g. adding extra fertility inputs when they notice that leaching has taken place).

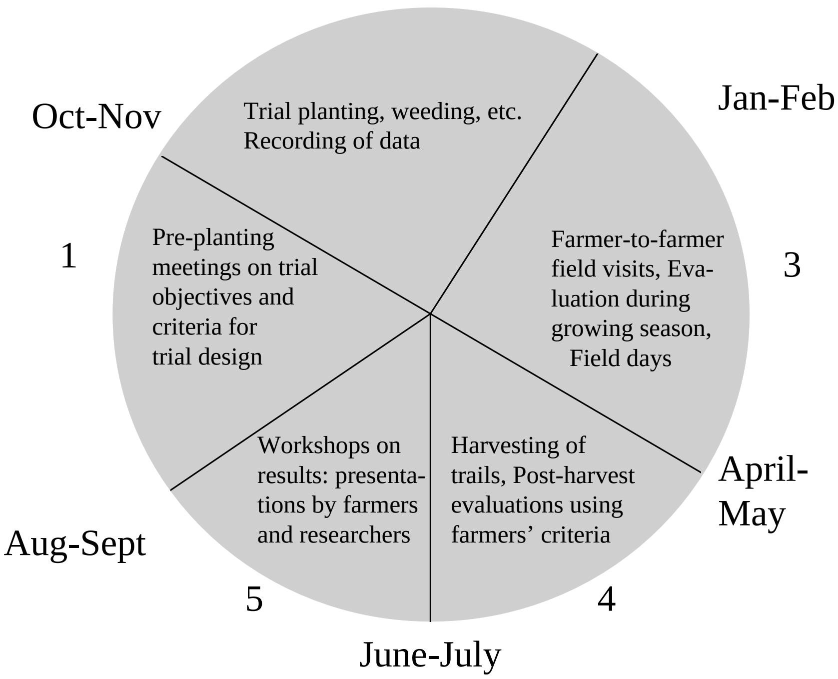
Such tensions between researchers and farmers in on-farm research encouraged the FSRU team to change its role. The involvement of farmers in all stages of the research process was adopted and capacity building for farmers' own research and analysis was supported. All trials remain farmer-led. Farmers debate among themselves on trial objectives, treatments and develop strategies for data collection, analysis, report writing and presentation. They also consult researchers. Researchers continue to identify specific technical problems and propose researchable options to farmers which they might find useful to carry out. Farmers in turn, often incorporate researchers' suggestions into their trials and test these alongside their own options.

Scheduling research activities

The research groups work according to a cyclical calendar (see figure 5). Farmer research activities for each season start with pre-planting meetings in September, when they decide on new trials, define objectives and develop a design. The trials are installed from October onwards and are maintained as required. Data will also be recorded. After 3 months, farmers will organise field visits to observe all the trials and make a first evaluation. Yield data will be recorded when the crop is harvested from April onwards. Farmers will again evaluate crop performance using their own criteria. Between July and

August, feed-back workshops are organised where the results of the past season are presented and discussed.

Figure 5: Calendar of research group activities



Pre-season planning meetings, farmer-to-farmer visits, field days, and workshops to evaluate results are all crucial interactive opportunities which enhance farmers' confidence in their ability to manage research themselves. Farmers use pictorial charts, maps, diagrams, exhibits, songs, dance and drama to convey their results and messages. Farmers have even enriched the local language by creating a terminology for the research activities. The participatory research process has been nick-named *zamapurani* meaning "try out a plan". A trial is referred to as *zviedzwa*.

Respect for culture

Researchers have to be aware of social norms and taboos when engaging in a process of on-farm research. They have to respect the days that farmers will not work for cultural reasons, such as *chisi* days, *rufu*, or worshipping or holy days and funerals. Mutual relations may be damaged irreversibly, if such days are ignored. Equally, local politicians, chiefs, headmen and kraalheads have to be respected and consulted. Some of them have also participated actively in the research group.

5 Challenges to the sustainability of farmer-led on-farm research

Limited financial and manpower capacity

Facilitation of farmer groups by researchers costs money. Exposure visits, farmer exchange visits, field days and workshops are essential activities which also need funding. More scientists will be needed to work with farmers, as the number of farmer research groups increases.

The role of station scientists

Historically, research stations were set up to improve commercial agriculture in Zimbabwe. Important achievements were obtained in crop breeding, fertiliser management, tractor-related land preparation and planting, pest and disease control, and soil and water conservation. Livestock research centred on beef and dairy production, with successful research carried out on stocking rates, pasture improvement, formulation of on-farm rations and animal disease control. However, resource poor farmers working in risky drought-prone semi-arid areas have hardly benefited from the results obtained at research stations.

The challenge for on-station scientists is to sustain farmers' own research by enlarging the range of relevant technology options available to them. For example on-station experimentation could focus on drought-tolerant open-pollinated crop varieties and how to preserve these on-farm. There is also a need for experimentation on nutrient-cycling using relatively cheap sources of organic fertilisers such as manure, termitaria, leaf litter and compost, to complement on-going farmer activity. The residual qualities of inorganic fertilisers could also be explored.

Responding to negative exogenous factors

The frequency of drought can cause repeated failure of on-farm experimentation and demotivate farmer groups. Participatory research will have to focus also on drought coping strategies by farmers and identifying ways of strengthening these.

6 Conclusions

By using an interactive and participatory approach, farmers have become co-researchers and co-analysts in research on developing and adapting sustainable technologies. The objective of these experiments is not to obtain an assessment that is statistically valid but rather one that is satisfactory within the context of a particular production system (Sumberg and Okali, 1988). Many would agree that the most important indicator when evaluating the quality of a new technology is the adoption rates by farmers (Chambers et al., 1989). In Chivi, 74% of the farmers involved in trials with maize varieties have adopted some of these, while tested soil fertility management techniques were adopted by 26% of the experimenting farmers (FSRU, 1997).

Our experience over the last five years suggests that using a participatory research process for the development of relevant technological options creates a viable framework for farmer-researcher interaction in the development of relevant technology options for small holder farmers. However, research scientists and their *zamapurani* counterparts have to provide the process with new and relevant technology options to maintain the momentum generated.

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