IMPROVING SOIL MANAGEMENT OPTIONS FOR WOMEN FARMERS IN MALAWI AND ZIMBABWE

International Crops Research Institute for the Semi-Arid Tropics

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Abstract

The collaborators' workshop held in September 2000 in Zimbabwe brought together stakeholders from Malawi, Zimbabwe, and UK, who actively participated in the Department for International Development (DFID)-supported project "Will women farmers invest in improving their soil fertility management? Participatory experimentation in a risky environment." The objectives of the workshop were to review and discuss the project results achieved during the 1999/2000 cropping season, assess how these results contributed to the project outputs, and agree work plans that better target the needs of women farmers in the activities during the following seasons.

Areas reviewed include the baseline economic surveys conducted in Zimbabwe and Malawi; results from field trials using a variety of on-farm approaches; and the on-farm approaches themselves. These approaches ranged from traditional researcher-managed on-farm trials looking at the interactions between nitrogen fertilizer and weeding, through to newer farmer participatory research (FPR) methods aimed at improving the interaction between the farmer and researcher. The FPR approaches include the mother-baby trial concept developed in Malawi to test the researcher-identified 'best bets' for soil fertility options under farmer-managed, farmer-led, researcher-designed trials to investigate legumes and manures, and interactions between FPR and crop simulation modeling. Based on the reviews and discussion of results, work plans for the 2000/01 season were enhanced to ensure the activities for each group of stakeholders contributed to the project outputs.

Improving Soil Management Options for Women Farmers in Malawi and Zimbabwe

Proceedings of a Collaborators' Workshop on the DFID-supported Project "Will Women Farmers Invest in Improving their Soil Fertility Management? Participatory Experimentation in a Risky Environment"

13-15 September 2000
ICRISAT-Bulawayo, Zimbabwe

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Contributors

The work hereby being reported follows continuing collaborative efforts between ICRISAT and research and development agencies from Zimbabwe and Malawi as well as international contributors from UK. Fanners participating in the project are from both Malawi (Dedza and Chisepo) and Zimbabwe (Zimuto and Tsholotsho). The following organizations were involved in the implementation and participation in the workshop:

Concern Universal, Malawi
Bunda College of Agriculture, Malawi
Department of Research and Specialist Services (DR&SS), Zimbabwe
Tropical Soils and Biological Fertility (TSBF), Zimbabwe
CIMMYT (Maize Research Station), Zimbabwe
Intermediate Technology Development Group (ITDG), Zimbabwe

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1. Welcome and Objectives

1.1 Welcome Address

M C S Bantilan[1]

Mr Chairman, invited guests, ladies and gentlemen, it is my singular honor to welcome you all, especially our colleagues from outside Zimbabwe, to Matopos Research Station and to this important meeting on the DFID-supported project, "Will women fanners invest in improving their soil fertility management? Participatory experimentation in a risky environment".

Ladies and gentlemen, the challenge we face as agricultural scientists working in the semi-arid sub-region today is great. Our research must aim to facilitate change at the farm level and not just to generate more scientific data. Per capita food production is generally on the decline in Southern Africa. The population in the semi-arid areas is continuing to grow. Rainfall is erratic and variable. And this is where the majority of the small-scale resource-poor farmers are found. Given such a scenario, the priority in the semi-arid farming systems would be, therefore, to increase the productivity and economic yield per unit of land and water.

The challenge we face is to devise effective and practicable solutions for the sustainable utilization of natural resources by farmers in the semi-arid tropics (SAT), within the constraints of their socioeconomic environment. Previous research has shown that it is only by fostering technologies which integrate improved soil quality, soil fertility, and water use that crop production can be increased in a sustainable way and the risk of crop failure minimized for farmers in the SAT. Improved varieties on their own have yielded marginal gains in productivity.

Sustainable agriculture has become a key component of production systems all over the world, given the evolution of such important factors as:

- Increasing concern about the degradation of the natural resources base;
- Low commodity prices leading to low-input systems; and
- An increasing concern about food security and improving the livelihoods of small-scale farmers.

The driving force behind sustainable agricultural systems is partnerships built on multi-institutional research approach, in which national agricultural systems, international agricultural centers, advanced research institutes, non-governmental organizations, local farming communities, and extension personnel work together

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in pursuit of common goals. Such an approach will not only give extra mileage to our efforts for a common cause, but also enable us to complement each other, to capitalize on our different strengths, and build on the initiatives already developed rather than reinventing the wheel every time. Bringing together researchers and farmers (the ultimate beneficiaries of the research products) promotes a fruitful exchange of ideas, experience, and most importantly, practical techniques the farmers themselves consider important in their social environment. Scientists are also afforded the opportunity to capture farmers' perceptions of their problems, their indigenous knowledge, their production objectives and priorities, for development and testing at an early stage. I am happy to note that this project is based on collaborative partnerships.

Looking at the objectives of this workshop, I feel this project deserves great commendation for paying special attention to women farmers, who are the backbone of agriculture in the region, and for targeting the creation of linkages.

Ladies and gentlemen, let me take this opportunity to formally introduce to you Dr Steve Twomlow and Dr Joseph Rusike. Both Steve and Joseph will be extensively working in this project. I am certain we will benefit a lot from the wealth of experience that they bring with them and also that their association with the region will enrich them considerably.

In conclusion, I would like, once more, to welcome you all to ICRISAT-Bulawayo. I am confident this workshop will be a success, and look forward to the outcome of the continuing process. I trust that our combined efforts will result in the development, transfer, and adoption of improved technologies, resulting in increased productivity and income which in turn will contribute to the economic empowerment of farmers, especially women farmers, in the drought prone SAT regions.

Thank you!

1.2 Workshop Objectives

S J Twomlow[1]

Workshop objectives

- To review and summarize the work carried out during the 1999/2000 season.
- To discuss proposed work plans and jointly agree on activities for the 2000/01 crop season.
- To review the outputs expected under the project.
- To discuss methods for better targeting the needs of women farmers.
- To discuss links with the CIAT (Centro Internacional de Agricultura Tropical) Participatory Methods Team.

Activities

- Overview of project objectives and outputs
- Overview and discussion of baseline surveys
- Presentation and discussion of results - Malawi
- Presentation and discussion of results - Zimbabwe
- Initial methods comparison review
- Presentation of proposed work plans
- Review work plans and agree common goal
- CIAT Participatory Methods Team presentation
- Methods to target women farmers
- Agree activities and reporting

Issues to be addressed

- Are we on target to achieve goal?
- Do female households constitute 50% of farmers?
- Female-headed households are the poorest and most food insecure! Is this true?
- Development of more practical investment options! Are we achieving this?
- Are risks and constraints to adoption being addressed?

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- Have women been involved in identifying research priorities?
- Should we be working only with women farmers?
- Develop methodology to link farmer participatory research with simulation modeling.

Where are we?

- Better characterize the crop management investment options and risks facing poorer, female-headed households in drought prone environments.
- Improve the ability of agricultural scientists and extension/non-governmental organization (NGO) farm advisors to facilitate crop management experimentation by women farmers.
- Define practical management options with poorer, women-headed households.
- Provide guidelines for integrating farmer assessment of technology options into national research and extension programs.

1.3 Overview of Project Objectives and Activities

David Rohrbach[1]

One target of this workshop is to track our progress in achieving the objectives and outputs defined under the DFID-financed project "Will women farmers invest in improving their soil fertility management? Participatory experimentation in a risky environment". I would like to briefly review these work plans and make a few comments on achievements.

The project has two overall goals. These are to:

1. Revise the way Malawi and Zimbabwe develop and disseminate new technologies suited to the needs of low resource farmers in drought prone regions, particularly female-headed households.
2. Increase the crop productivity of female-headed households in drought prone regions.

We have agreed to pursue these goals by developing methodologies for linking farmer participatory research with crop systems simulation modeling through case studies targeted at improving the welfare of women farmers. This is a big endeavor. Nonetheless, we expect at least to draw lessons benefiting other research and development practitioners pursuing similar goals.

The project encompasses four major objectives. These are to:

1. Better characterize the crop management investment options and risks facing poorer, female-headed households in drought prone environments.
2. Improve the ability of agricultural scientists and extension or non-governmental organization (NGO) farm advisors to facilitate crop management experimentation by women farmers.
3. Define practical management options with poorer, female-headed households.
4. Provide guidelines for integrating farmer assessment of technology options into the programs of NGOs, research organizations, and extension agencies.

We expect to discuss specific progress toward achieving each of these objectives over the next two days. We will then outline means to improve this progress on day three of the workshop.

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The project activities and corresponding outputs are summarized in Table 1. In my understanding, we have essentially completed activities 1-3 and activity 6. We expect to discuss activity 4 in this workshop. And we will complete the planning for the coming year's experimentation.

Table 1. Project milestones and outputs.

Milestone (time bound activity)	Corresponding output
1. Project stakeholders' meetings (month 2)	Agreement on locations of research, timing, and distribution of project implementation responsibilities (month 2)
2. Baseline surveys of crop management technologies applied by female-headed households, experimentation underway, and further experimentation sought (months 3-7)	Baseline report summarizing the historical development and adoption (or lack thereof) of extension soil fertility recommendations for semi-arid systems, and summarizing alternative fertility management strategies of female-headed households (month 9)
3. Training of project scientists, national agricultural research systems (NARS) and NGO collaborators, and farmers in participatory research techniques (month 4)	Trained researchers, extension staff, and farmers in participatory methods of technology experimentation (month 4)
4. Year one of farmer-led experimentation of alternative fertility management options (months 4-11)	Report summarizing a range of more practical crop management options for dissemination to poorer households (month 12)
5. Stakeholders' meeting to discuss results of first year's surveys and experimentation (month 12)	Plan for the second season of experimentation with farmers (month 12)
6. Training of project scientists in applied simulation modeling techniques to facilitate experimental results interpretation (month 12)	Trained NARS research scientists in applied systems simulation modeling (month 12)

continued

Table 1. continued

7. Year two of farmer-led experimentation of alternative fertility management options (months 16-23)	Report summarizing a range of more practical crop management options for dissemination to poorer households in each country's semi-arid farming systems (month 24)
8. Survey examining farm/non-farm investment decision-making of female-headed households (months 21-23)	Report summarizing tradeoffs in investment options between crop management and other farm and non-farm investment opportunities (month 24)
9. Stakeholders meeting to discuss results of second year's surveys and experimentation (month 24)	Recommendations for revisions of specific extension recommendations (month 24); report summarizing lessons learned by project collaborators in participatory research for developing more practical crop management recommendations (month 24)
10. Complete reports on case study lessons and guidelines for practical application elsewhere (months 25-30)	Guidelines for linking applied participatory research and modeling to develop more practical extension recommendations in other countries in southern Africa (month 30)

Renewed priority needs to be attached to activity 8. This effort will be advanced with the appointment of Joseph Rusike by ICRISAT last month. In addition, we need to start to draw lessons about both the methods being tested in this project, and about the technologies of particular reference to women.

At the end of our last annual workshop, we agreed to place emphasis on a comparison of on-farm participatory research methods. We organized the comparison of three different on-farm research efforts, and a non-intervention control, in each of 2-3 experimental sites in Zimbabwe and Malawi. This comparison can briefly be summarized to encompass:

- Model 1

  Control village: no intervention, no visits.
- Model 2

  Demonstration village: soil fertility demonstration trials.

- Model 3

  Researcher-led village: mother and baby trials on best bet soil fertility options.
- Model 4

  Farmer-led village: training for transformation and facilitation of farmer experimentation.

Unfortunately, as we started to review what was actually being implemented by this research team, we found that this design was not strictly adhered to. In practice, research designs were modified by scientist interests, and by the evolution of discussions with each community. I am sure there are many useful lessons inherent in these decisions. Nonetheless, we then asked Dr Ade Freeman to conduct a quick review of the trial designs actually implemented. Specifically, he was to check the degree of conformity with the original four models, and evaluate whether we still have a basis for methods comparison. Dr Freemen will discuss his findings later in this workshop.

The second concern is the question of how well we have targeted the needs and capabilities of women farmers. During the last workshop we discussed the value of distinguishing between male-headed households, *de facto* female-headed households (those with migrant male heads), and *de jure* female-headed households (those without a male head). We need to return to these discussions as we evaluate specific technology options. Can we begin to draw conclusions relating to the need for technology targeting?

2. Overview of Baseline Surveys

2.1 Zimbabwe Baseline: Crop Management Options and Investment Priorities in Tsholotsho

David Rohrbach[1]

A main question underlying this project is whether women farmers will invest in technologies for improving the fertility of their soils. The underlying assumption is that female-headed households face more severe capital and labor constraints than male-headed households. Female-headed households are also assumed to experience greater difficulty obtaining agricultural inputs and extension support. Consequently, they are likely to require different soil fertility technologies. This proposition was first to be examined in the context of the baseline surveys. Then it was to be tested through participatory experimentation with both male and female farmers. This presentation again reviews some of the baseline survey results. For the sake of simplicity, the presentation highlights the data from Tsholotsho, one of the two trial areas in Matabeleland.

About 60% of the households in Tsholotsho are female-headed. This is high compared to other parts of Zimbabwe, because migration to South Africa has been easier from this part of the country. The proportion of female-headed households in Gwanda, our second trials site in Matabeleland, is similar. But it is also important to note that 23% of these are *de jure* female-headed, meaning that there is no male head. Approximately 36% are *de facto* female-headed, meaning that husbands are working elsewhere. Many of these men send back remittances in kind or cash. In general, *de facto* female-headed households are relatively cash rich, because of their remittances. The main question is whether this cash will be invested into farming. The *de jure* female-headed households are commonly the poorest in the rural areas.

Somewhat unexpectedly, we find that all three classes of households have access to about the same amount of farmland in Tsholotsho. However, draft constraints limit the proportion of this area that can be planted. Male-headed households tend to own more draft animals (both cattle and donkeys), and plant more land. They are also more likely to own plows and ox-carts. Female-headed households own fewer draft resources and farming implements. The *de jure* female-headed households own the fewest number of animals and implements. As a result, they are less likely to plant their fields on a timely basis relative to the

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rains, and commonly plant less than one-half of the land available to the household. This reduces yields and harvests, perpetuating their impoverished condition.

Male-headed and *de jure* female-headed households have approximately the same amount of labor available on the farm. *De facto* female-headed households have an average of one fulltime equivalent worker less than the other two categories. But in general, none of these household classes appear to be severely labor constrained.

The largest difference among the three household classes is in the availability of cash income. While these data are not particularly accurate in recall surveys, the magnitude of this difference suggests an important distinction. The results indicate that *de facto* female-headed households have three to four times more cash income compared with male-headed and *de jure* female-headed households. There is strong evidence of a significant flow of remittances from male-heads working elsewhere back to these rural households. The question is whether this cash will be invested back into the farming system. Or will it be primarily used for consumption, and to support the migration of other family members?

The planting of cereal grain crops (maize, sorghum, and pearl millet) tends to be prioritized by all households. There seems to be no gender specific determinant of the choice of grains, and most households plant both maize and sorghum or maize and pearl millet. If rains are favorable, the maize yields well. If rains are poor, the maize may fail, but the sorghum or pearl millet provides a food security crop.

The largest relative imbalance in crop area allocations is in legumes, principally groundnut, and bambara nut. Farmers able to plant a larger total farm area plant more legumes. In the baseline data for Tsholotsho, male-headed households plant three to four times more legumes than female-headed households. Though groundnut is commonly perceived as a woman's crop, the area planted to this crop still depends on the capacity of the household to first meet its grain production objectives. Again, due to draft and cash constraints, *de jure* female-headed households plant the smallest area to legumes.

The availability and use of farmyard manure is related to the availability of cattle and ox-carts. While some households use goat manure, most of the manure being applied comes from cattle. Male-headed households are substantially more likely to apply manure, though less than one-quarter of these households apply this input. As indicated in earlier presentations, up to 60% of the households in southern Zimbabwe with access to cattle manure are not using this input. It is common, in Matabeleland to see heaps of manure left by the homestead and never used. Farmers cite many reasons for this including the fear that the manure will burn their crops, transport constraints, and the perception that their soils are still fertile. Female-headed households are less likely to have access to manure, and less likely to use this input when available. Average application rates among the farmers using manure generally range around 2-8 t ha^{-1}. This is substantially less than the rate (25-35 t ha^{-1}) advised by the local extension services.

Less than 10% of these farmers use chemical fertilizer. Unexpectedly, there appears no relationship between the availability of cash in the households and the likelihood that fertilizer will be purchased. Also chemical fertilizer is not commonly offered in remittances. Female-headed households are just as unlikely to use chemical fertilizer as male-headed households. In general, farmers in Matabeleland seem skeptical about the payoff to the.application of this input. Chemical fertilizer is expensive, and generally not accessible in the rural market. But farmers also commonly perceive that fertilizer will burn their crops. This led some farmers to avoid using this input even when it was provided free in the past drought relief programs.

In a hypothetical question, the baseline survey asked farmers how they would invest ZW$ 2,500 (about US$ 66 at the time of the survey). We were curious to obtain an approximate sense of the relative priority attached to investments in crop versus livestock enterprises. As has been found in previous surveys, the largest share of this cash would be invested in livestock. This would be used to help build herd sizes. Less than one-quarter of this money would be invested in crop production though the investment in more cattle would allow farmers to plant a larger portion of their land on a more timely basis.

Will women farmers invest in soil fertility management technologies? And if so, will women-headed households invest in different sorts of technologies compared with male-headed households? This remains a difficult question to answer on the basis of survey results alone. Basic questions remain about the proclivity of these households to invest in crop production compared with the pursuit of off-farm income. However, certain relationships in the data suggest important differences in investment profiles between male- and female-headed households that ought to be considered in the course of participatory experimentation.

Male-headed households tend to have more cattle, and therefore more manure. They are also able to plant a larger area on a more timely basis. These households will plant more legumes area. However, they tend to use very little chemical fertilizer, and many do not use the manure available to them. In effect, these farmers have adopted a relatively extensive set of farming practices. They will plant more fields over a longer period in order to reduce the risks of losses due to drought, especially mid-season drought. Will these farmers shift from an extensive to a more intensive cropping practice? A key initial target could be to increase the use of available manure and improve the effectiveness of this input. Consideration could also be targeted toward improving the efficiency of legume rotations.

De facto female-headed households are relatively cash rich, but have marginally less household labor. They are intermediate in their access to livestock and implements. The key question here is whether these households will invest in farming, or whether they primarily view their future in off-farm employment. Is the farm essentially a source of labor for the non-farm economy? Or will these farmers invest part of their cash in improving their household food production? The survey results suggest these households are likely to remain subsistence oriented. They seem to target a limited investment in meeting their family food supplies. They may invest in livestock, but seem inclined to allocate a larger share of their cash to non-farm investments. Technology options suited to these households could target the assessment of the relative returns to cash invested in inputs like fertilizer or manure in comparison with the returns to school fees and labor migration.

De jure female-headed households are the most difficult to help. These are the poorest farmers in Tsholotsho. Land and labor are not particularly constraining. But draft and implement resources are severely constrained. These households also have very limited cash. Consequently, manure and fertilizer technology options may be impractical for most of these farmers. There may be scope for encouraging larger plantings of legumes as both intercrops and rotations. However, these must fit a strategy of first achieving a basic level of cereal grain supply.

In sum, the baseline survey data indicate important differences between male- and female-headed households. Also, there are large differences in the investment profiles of *de facto* female-headed households and *de jure* female-headed households. Each of these classes of farmers appears likely to benefit from different sorts of technology options for improving their soil fertility. The next question is whether these differences can be confirmed during the course of participatory experimentation.

2.2 Zimuto (Zimbabwe) Baseline Survey

S J Twomlow[1]

A baseline survey was conducted in May 2000, covering 167 households in and around Zimuto Communal Area, Masvingo District, Zimbabwe, jointly by three projects working closely together in the study area:

- DFID Project R7260 "Will women farmers invest in improving their soil fertility management? Participatory experimentation in a risky environment"
- AusAid Project "CIMMYT Southern Africa Risk Management Project"
- DFID Project R7474 "Weed management options for seasonally inundated land in semi-arid Zimbabwe"

The purpose of the survey was to:

- Collect baseline data on smallholder farmers' crop management practices.
- Establish baseline adoption levels for technologies likely to be targeted by the research projects.
- Provide detailed socioeconomic data on different households, access to resources and how this access might by influenced by the gender of the head of household.
- Complement socioeconomic data collected from focus group discussions held.

A preliminary analysis of the baseline survey indicates that 71 % of households were headed by men and 29% by women (Table 1). Of the female-headed households, 10% were *de facto* heads (with husbands away or living with their spouse) and 19% *de jure* heads (single, widowed, or divorced).

Table 1. Head of households (%) in different categories.

Household	Male	Female *de facto*	Female *de jure*	Total
Single	3		1	4
Married living with spouse	58	6		64
Married with head away	7	4		11
Widowed	2		17	19
Divorced	1		1	2
Total	71	10	19	100

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Resource categories

Through a series of participatory wealth ranking exercises farmers categorized households in the area into four resource groups (RGs) based on livestock ownership, arable field types, and implement ownership. This four-part categorization was then used for classifying each respondent interviewed and showed a strong correlation with inputs used and yields achieved. The percentage of households in each resource category was 24% in RG1, 44% in RG2, 17% in RG3, and 16% in RG4. This illustrates that access to draft animals and implements are key factors influencing timeliness of operations and area cultivated. The timeliness is particularly important in that it effects production by an early plowing and planting to let farmers make best use of the first planting window and stagger their operations over the whole season. In contrast to the other baseline surveys carried out in Zimbabwe and Malawi, there appears, from the initial analysis, to be no gender-related differences in farm size, draft animal power availability, or input use (Fig. 1). However, there was a strong correlation between resource categories and age (Fig. 2).

The percentage of farmers falling into each RG for Chikato and Maraire, two of the case study villages in Zimuto are summarized: 15% RG 1, 26% RG2, 28% RG3, and 31% RG4 in Chikato; and 26% RG1, 10% RG2, 22% RG3, and 42% RG4 in Maraire. Farmers collaborating with the project are more than representatives of

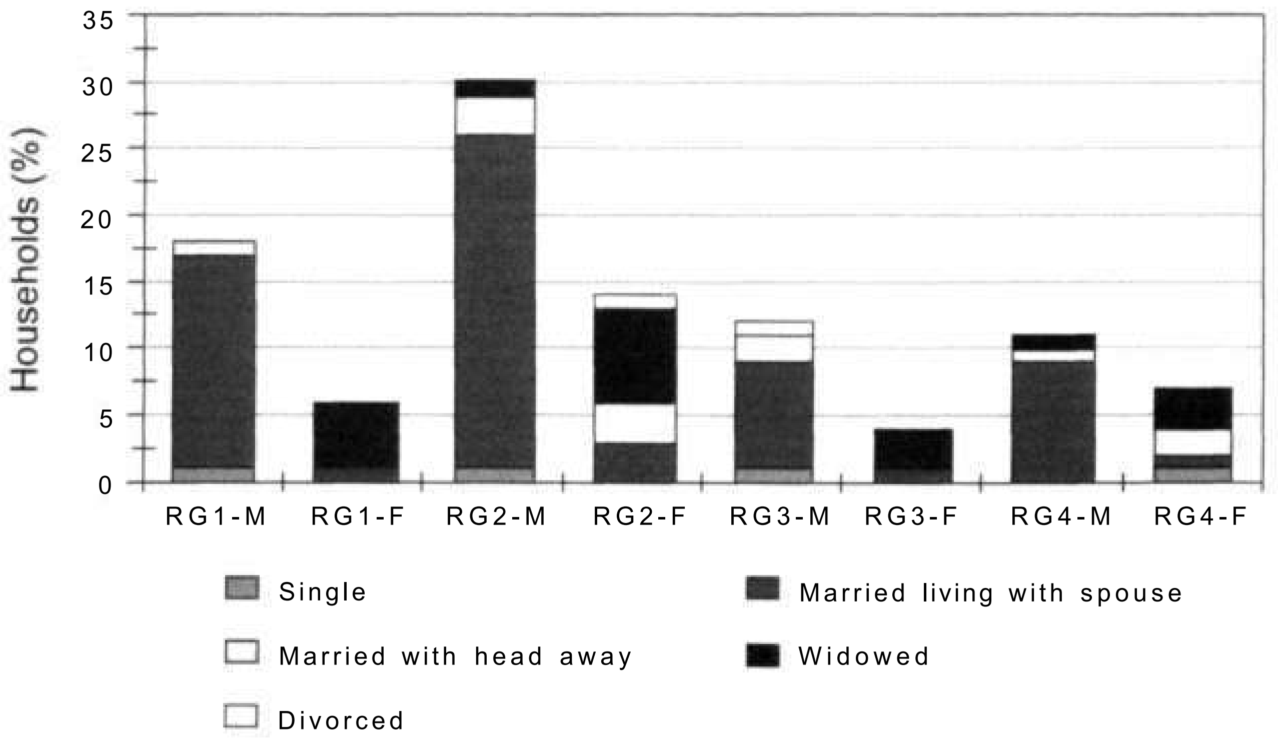

Figure 1. Status of heads of households (M = male; F = female) by resource group (RG).

the below average resourced farmers (RGs 3 and 4), with each RG comprising at least 50% female-headed households.

The household assets of each RG have a dramatic influence on the crop production constraints faced by a household and how they might overcome them (Table 2).

Table 2. Crop production constraints faced by farmers in Zimuto, Zimbabwe.

Problem (in order of priority)	Solution
Lack of cattle	Hiring in draft power might offer a solution, but this can be achieved after a long time. Currently, draft power is hired at ZW$ 1480-1730 ha^{-1}. Tractors can be hired at ZW$ 1600 ha^{-1}. The major problem with tractor hiring is that it is not easy for a farmer to get one. Farmers said that they could practice reduced tillage, but this increased weeds and cut worm damage to crops. The advantage with this practice is that soil nutrients are conserved and yields are higher provided there is enough rainfall.
Fertilizer shortage	Compost, fertilizer, and leaf litter application. Putting crop residues into the kraal. Hiring out labor for cash to buy fertilizers.
Seed availability	Planting seed from the previous harvest (F_2 seed) but this requires fertilizers. Buying seed in time.
Cash	Growing vegetables for sale. Poultry projects.
Weeds	Weeding often. Sourcing cash for hiring in labor. Embarking on collective work. This is done to provide labor among farmers.

Initial results from the survey show that there was a significant difference between the physical assets of the different RGs, particularly livestock (Fig. 3) and implements owned (Fig. 4).

Access to assets had a significant impact on household incomes and its sources. Overall the most important source of income was from dryland crops.

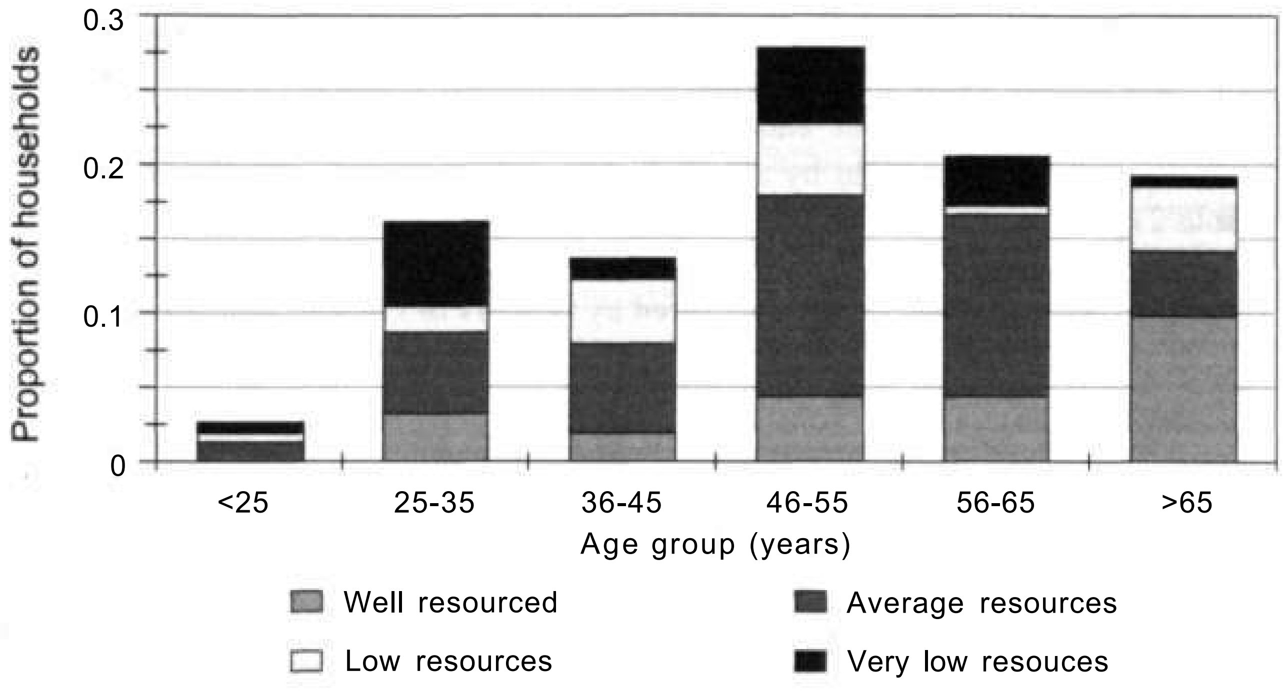

Figure 2. Proportion of households in different age groups relative to resource category.

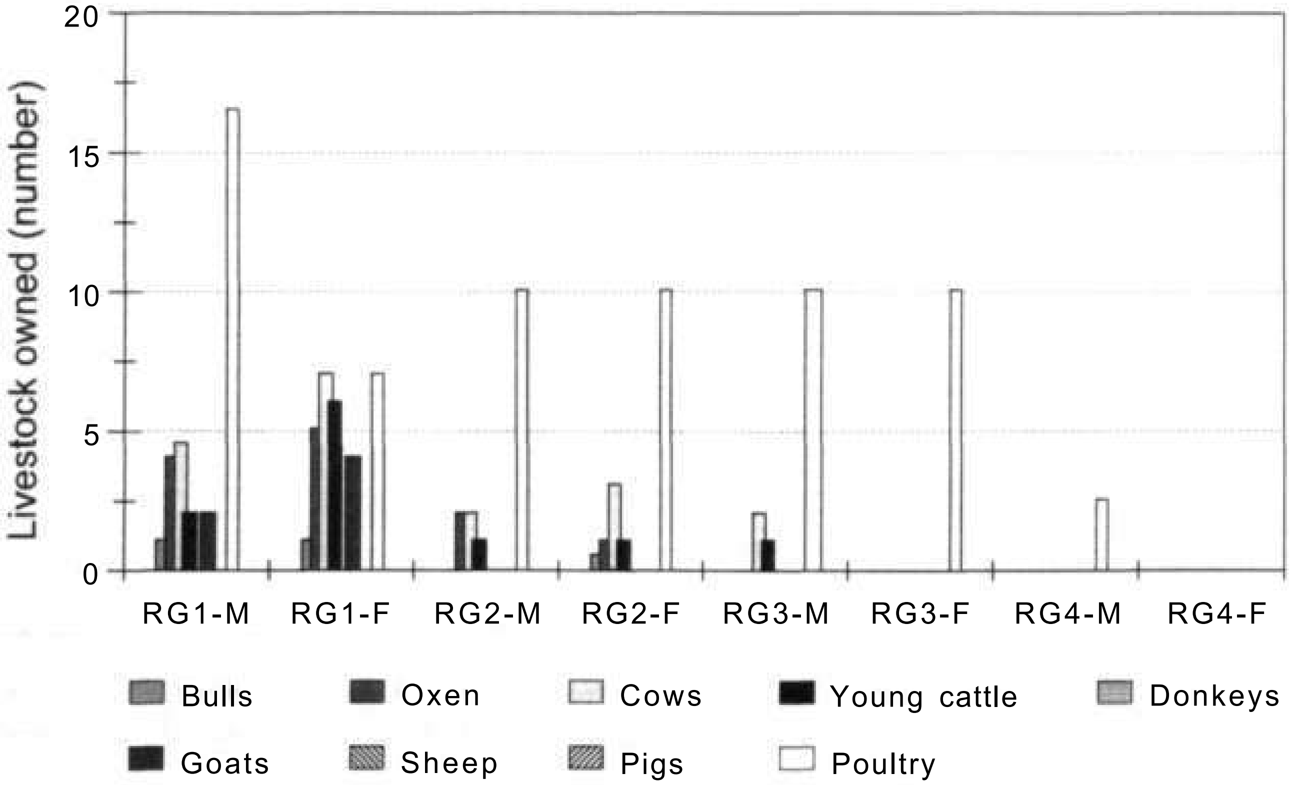

Figure 3. Livestock owned by different resource categories of male-headed (M) and female-headed (F) households.

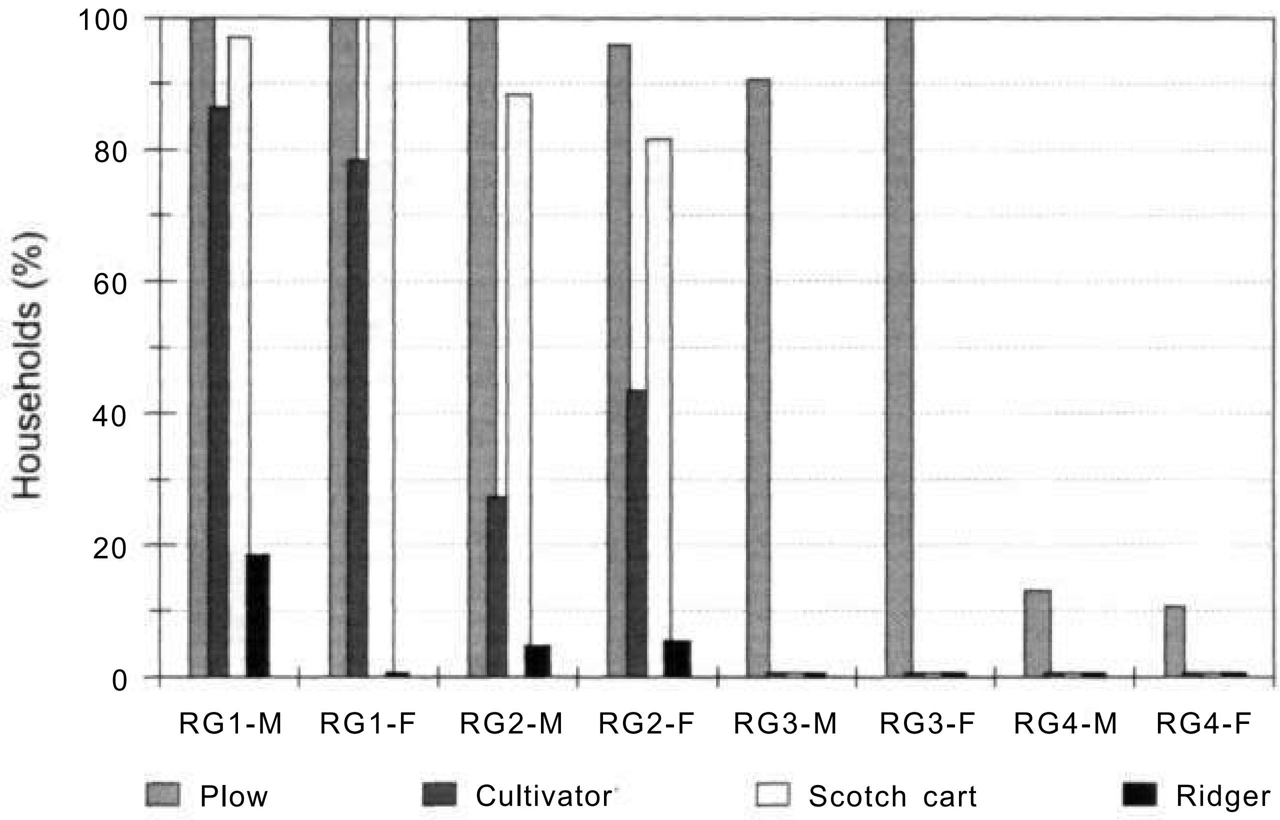

Figure 4. Implements owned by different resource categories of male-headed (M) and female-headed (F) households.

Field types in Zimuto

Within the Zimuto area there is a great deal of variation in soil types across the soil catena. This together with crop management practices and soil types has resulted in a number of different field types, all of which receive different levels of resources and crop production practices. The distinction between field types, and their classification is well recognized and used by households to classify different fields. Management operations and prioritization of activities relate to different field types and plots. In Zimuto households identified three main field types, namely vlei, topland, and homestead fields, with many households also having a garden plot.

Lower resource categories characteristically cultivated smaller areas of each land type with RG4s having a greater proportion of homestead fields and toplands than other groups (Table 3). Most land preparation takes place from August through to December (Fig. 5) with toplands planted mainly in November. Where gardens were cultivated, this comprised irrigated topland (33%), rainfed topland (9.5%), irrigated vlei (37%), and rainfed vlei (25%).

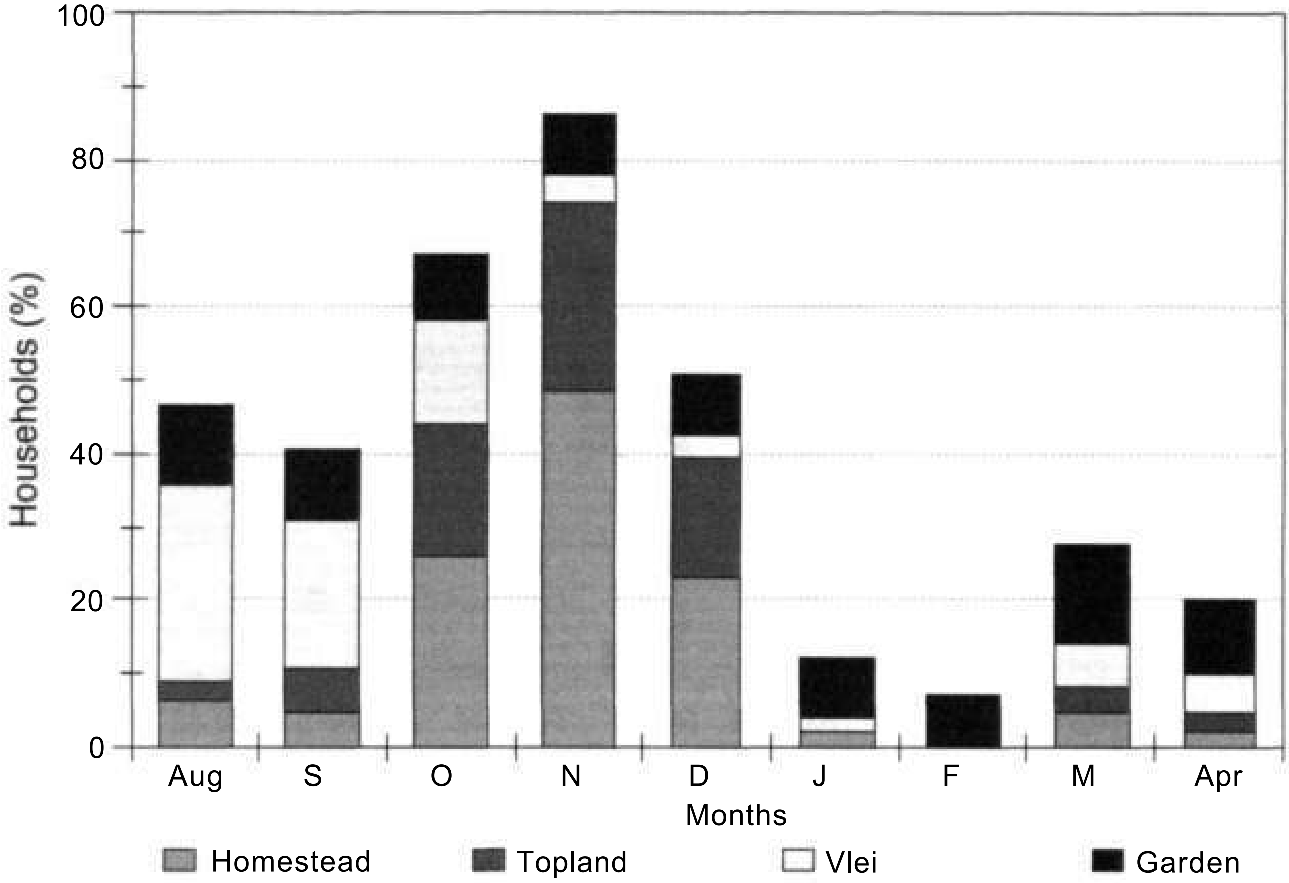

Figure 5. Time of land preparation on different land types in Zimuto, Zimbabwe.

Table 3. Area (ha) of each land type in the four household resource groups (RGs).

Land type	RG1	RG2	RG3	RG4	Total
Homestead	0.9	0.7	0.5	0.6	0.7
Topland	1.5	0.8	0.7	0.5	0.9
Vlei	1.2	0.8	0.7	0.3	0.8
Garden	0.2	0.1	0.1	n[1]	0.1
Total	3.8	2.4	2.0	1.4	2.5

1. n = negligible (0.01 ha).

Household soil fertility management

Households used different soil fertility management practices (Table 4). Over 75% of households used a crop rotation on their homestead and topland fields, and about 50% on the vlei lands. The main reasons given for the use of rotations was enhancing soil fertility (95%). Other important considerations were crop diseases (28%), pests (23%), and weeds (14%). Application of soil fertility treatments was almost entirely confined to maize with other crops receiving no fertility treatment other than the residual effects of treatments supplied to maize. The lower RGs were less likely to use soil fertility management practices (Fig. 6). Use of soil fertility treatment on different land types by different resource groups showed significant differences (Figs. 7 and 8).

Typically 50% of cash expenditure is on purchasing fertilizer (Fig. 9). This was approximately ZW$ 1000 and varied from ZW$ 2000 to less than ZW$ 500, the lower resource groups spending proportionately more money on the purchase of seeds than the wealthier groups.

Table 4. Percentage of households using different soil fertility practices.

Fertility practice	Homestead fields	Toplands	Vleis	Gardens (summer)	Gardens (winter)
Rotations	77	75	52		
Manure	60	29	33	60	91
Anthill soil	18	7	7	69	81
Compound D at planting[1]	32	20	18	51	83
Compound D at topdressing	10	6	4		
Ammonium nitrate as topdressing	73	39	38	72	78
Compost	43	7	3	55	90
Leaf litter	16	2	2	72	72
Lime	1	2	1	0	0

1. Compound D (or D) fertilizer contains 8% nitrogen, 6% phosphorus, 6% potassium, and 6.5% sulfur.

Some initial conclusions

- Major differences between RGs.
- Minor differences between male- and female-headed households.
- Widespread use of different soil fertility management systems.
- Manure widely used when available.
- Understanding of the use of ammonium nitrate (AN).
- No mention of use of agroforestry or green manures.
- Less inorganic fertilizer used because of high cost.
- Relatively small areas of legumes are grown.
- Available organic sources (leaf litter, anthill soils) are becoming rare.
- Need to bring in organic material.

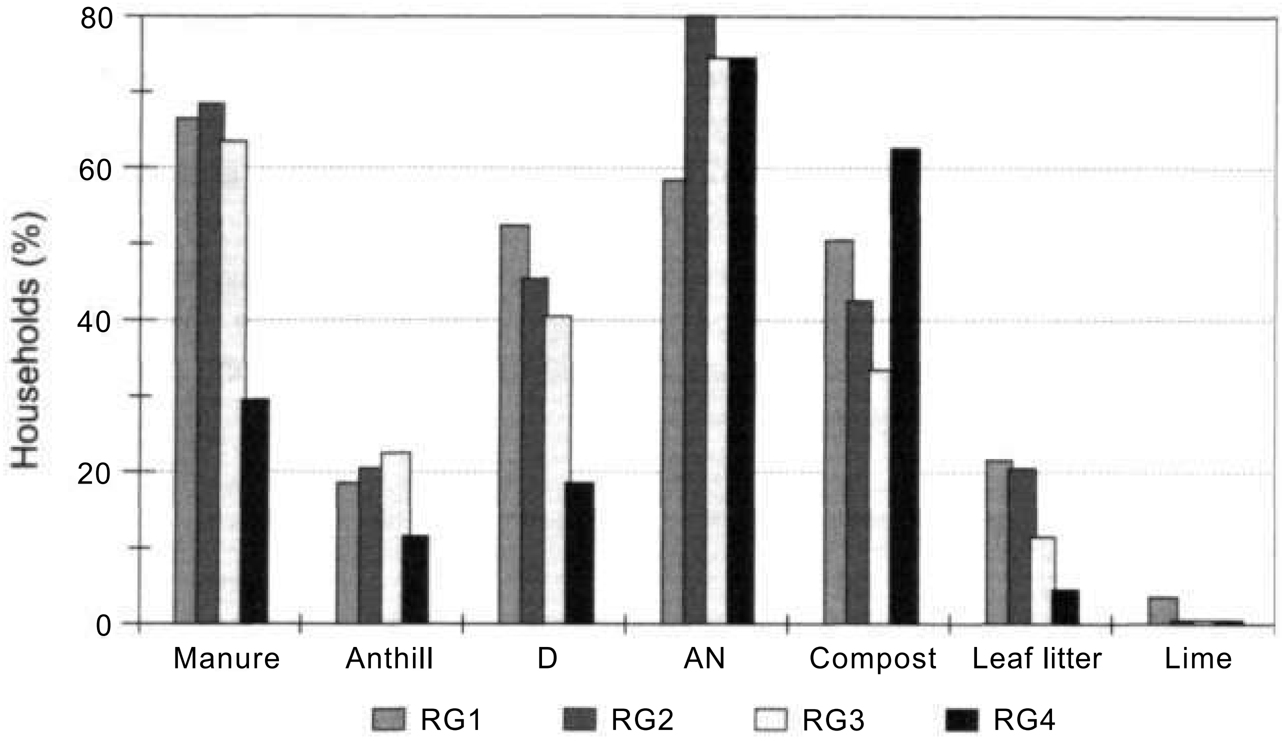

Figure 6. Use of different soil fertility management practices by resource groups (RGs).

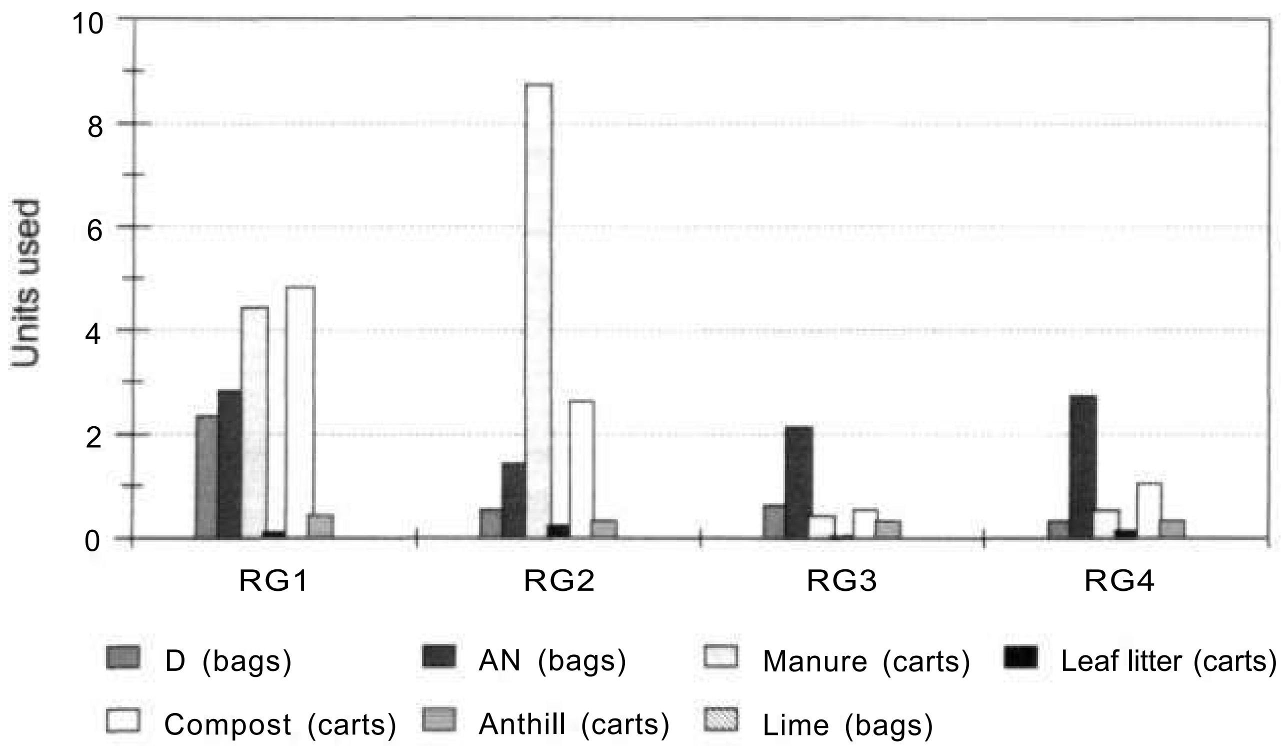

Figure 7. Soil fertility management by different resource groups (RGs) in homestead fields.

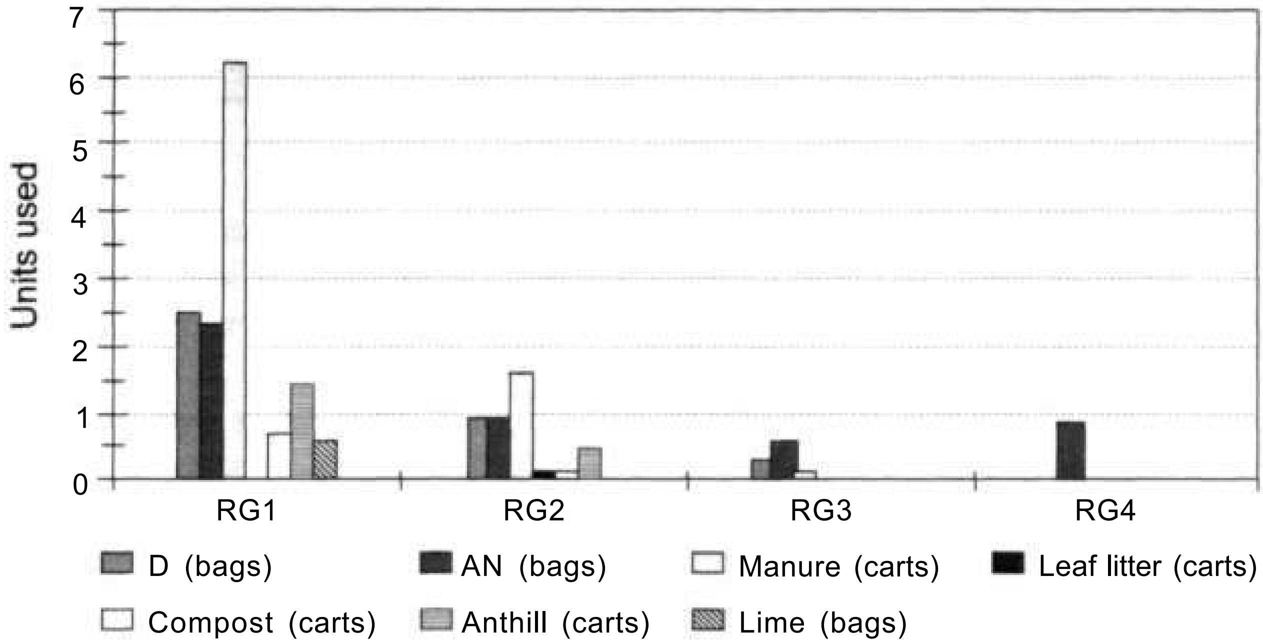

Figure 8. Soil fertility management by different resource groups (RGs) in topland fields.

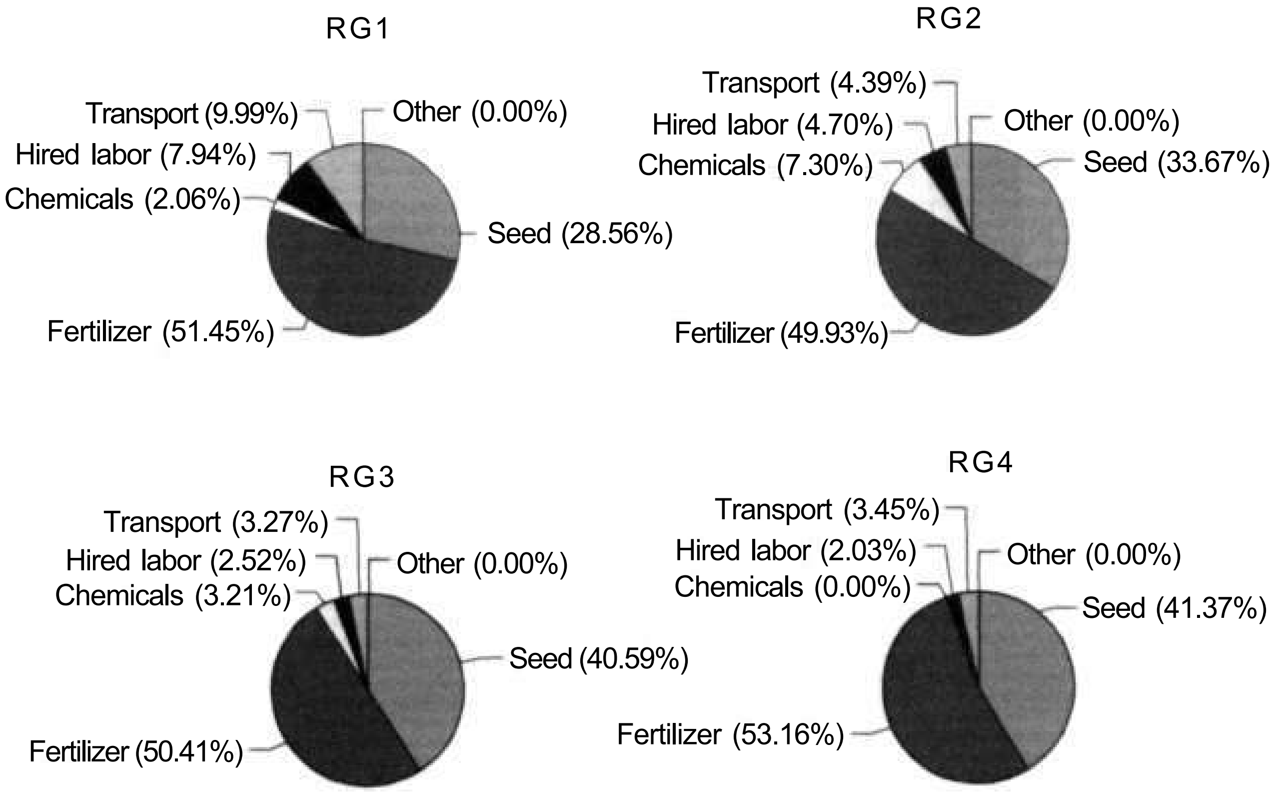

Figure 9. Cash expenditure on crop inputs by resource groups (RGs).

2.3 Malawi Baseline Survey Report

Ade Freeman[1]

A baseline survey was conducted during the 1998/99 cropping season, covering 329 households in central and southern Malawi. The households were located in Kasungu, Lilongwe and Machinga Agricultural Development Divisions (ADDs). The objectives of the survey were to:

- Collect baseline data on smallholder farmers' crop management practices and how the gender of the household head might influence these practices.
- Help set priorities for participatory crop management research.

Characteristics of households

About 72% in the sample were male-headed households (MHH) while the rest were female-headed households (FHH) with *de jure* female headed (24%) being more than the *de facto* female headed (5%). The percentage of *de jure* FHH was 12% in Kasungu, 23% in Machinga, and 40% in Dedza, while the *de facto* FHH was 5% in the three ADDS (Fig. 1).

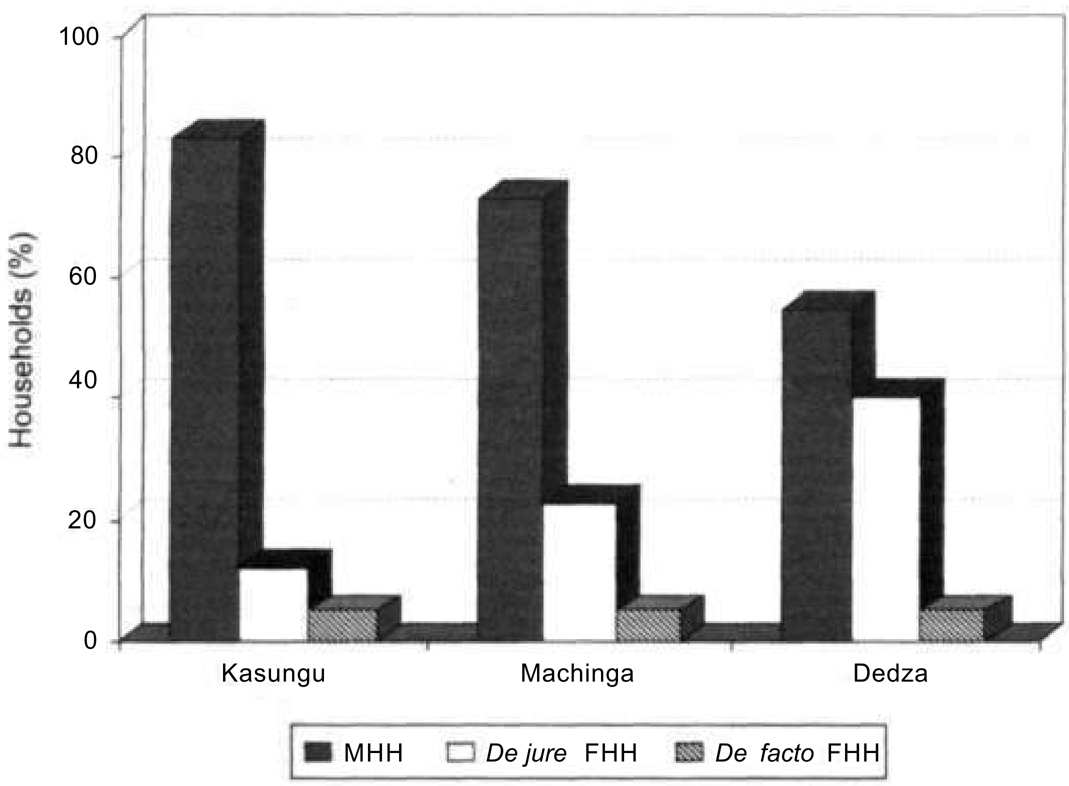

Figure 1. Percentage of male- and female-headed households at three locations in Malawi.

1. ICRISAT-Nairobi, P O Box 39063, Nairobi. Kenya.

Only a small proportion of households surveyed in the three ADDs produced any food grain surplus, while the majority had a food deficit (Figs. 2 and 3).

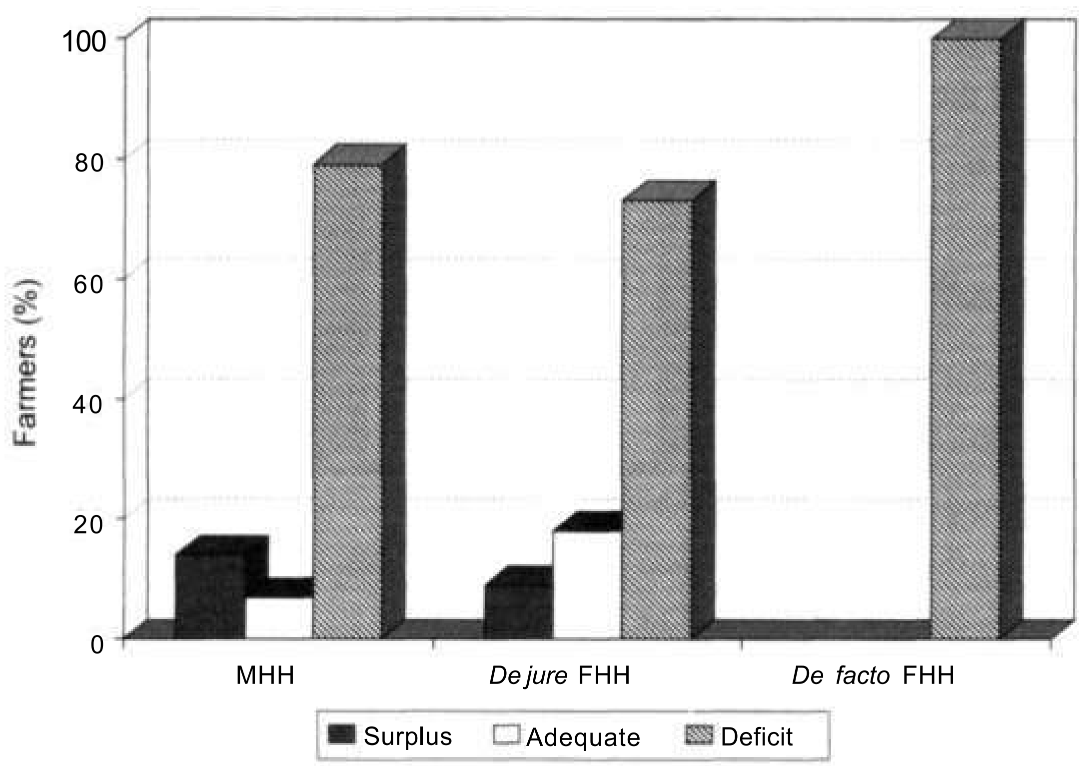

Figure 2. Household grain production levels in Kasungu.

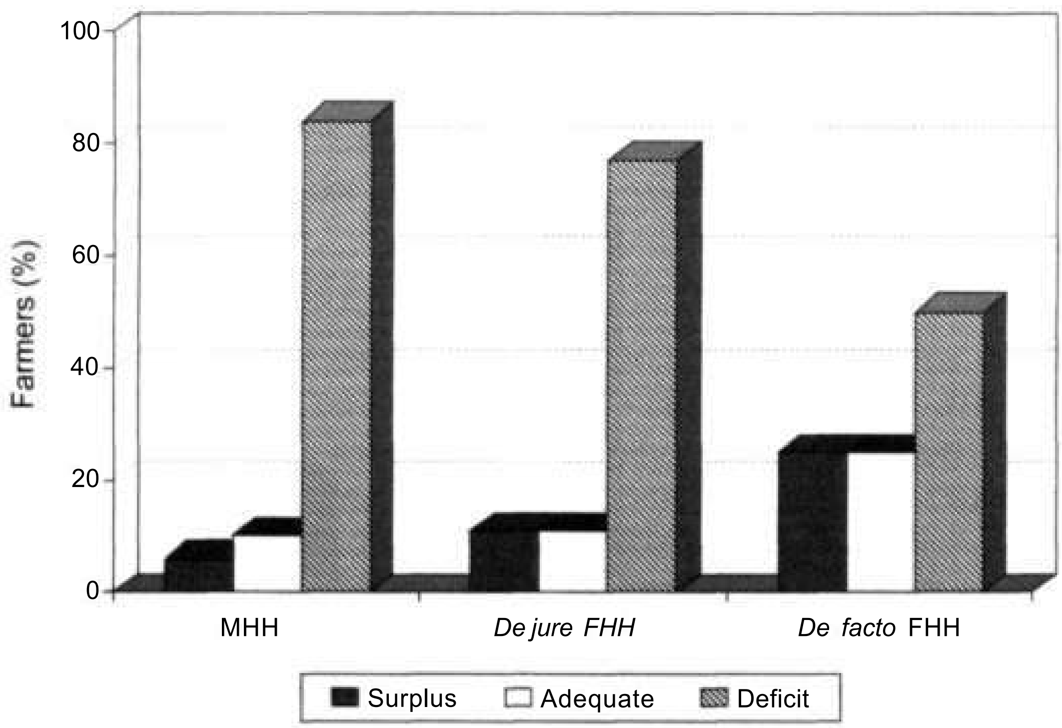

Figure 3. Household grain production levels in Dedza.

Land and crops

The sampled households had an average land holding of 2.1 ha (Fig. 4), of which 1.7 ha was cultivated while the remaining land was under fallow. In Kasungu the land owned was 2.6 ha for MHH, 1.7 ha for *de jure* FHH, and 1.6 ha for *de facto* FHH; most of the land was cultivated (Fig. 5). Similarly, although not statistically

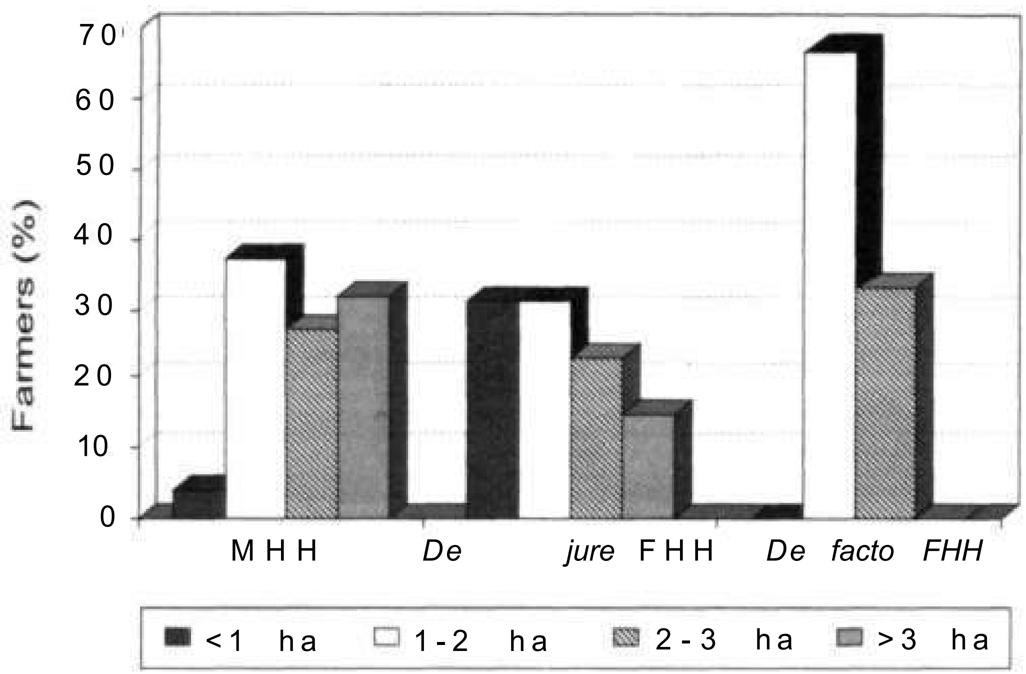

Figure 4. Land distribution in Kasungu according to the status of head of household.

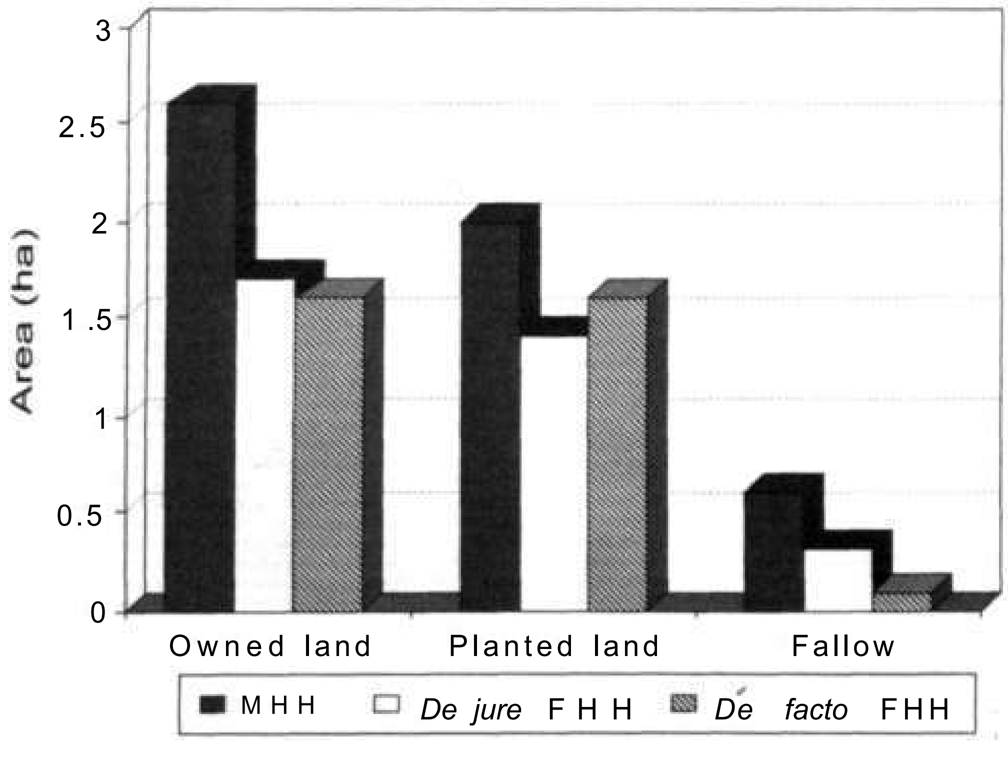

Figure 5. Area cropped in Kasungu according to status of head of household.

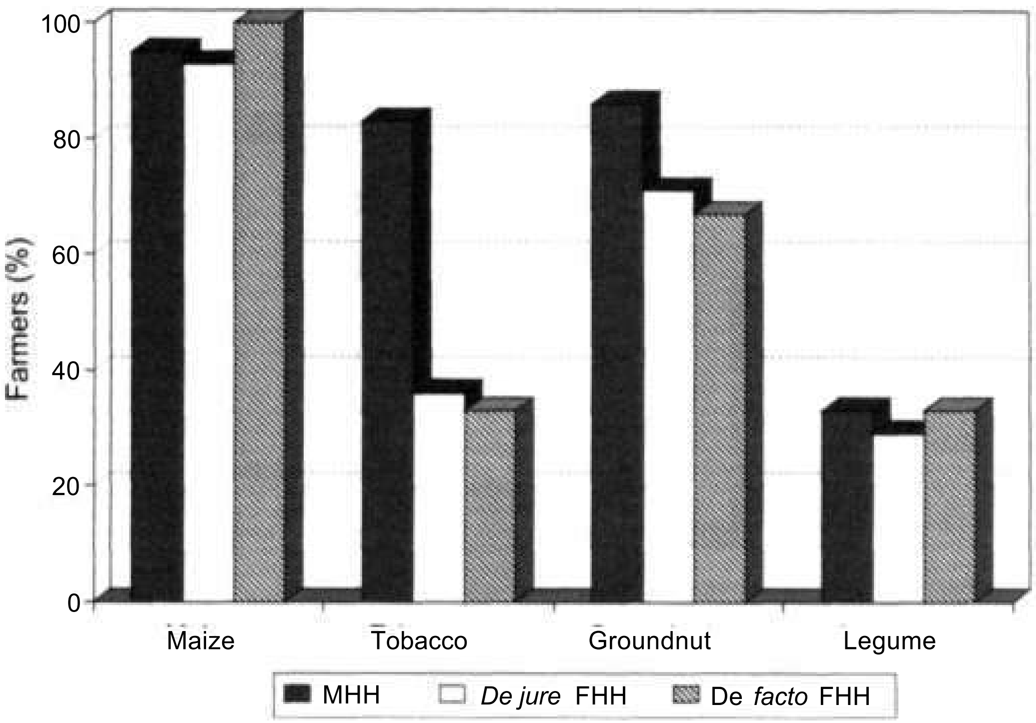

Figure 6. Distribution of crops according to the status of head of household in Kasungu.

important, the land owned in Machinga was 1.7 ha for MHH, 1.4 ha for *de jure* FHH, and 1.2 ha for *de facto* FHH. However, in Dedza *de jure* FHH owned more land (2.6 ha) compared to both MHH (2.0 ha) and *de facto* FHH (1.9 ha).

The major crops grown were mainly maize, tobacco, cotton, groundnut, beans, and soybean (Fig. 6). All households normally grew maize but 2% of MHH in Kasungu had not grown it in the previous season. Maize grown was 0.8-1.0 ha in Kasungu, 0.6-0.7 ha in Machinga, and 1.0-1.6 ha in Dedza. There was more land under maize in Dedza than in Kasungu or Machinga perhaps due to the fact that Dedza households did not grow cash crops such as tobacco or cotton.

Labor availability

All households in the three ADDs had at least one full-time family member working on the farm. There were 3 full-time family workers in MHH while *de jure* FHH and *de facto* FHH had 2 full-time family workers. The MHH had 2 part time family workers while *de jure* and *de facto* FHH had only one. About 7% of MHH, 7% of *de jure* FHH, and 25% *of de facto* FHH had at least one part time family worker. The percentage of households with part time family workers was 13% in Kasungu, 7% in Machinga, and 1% in Dedza.

About 21% of the farmers hired labor to be used in agricultural production. The percentage of households in Kasungu that hired labor and hired out household labor to others (i.e., *ganyu)* is presented in Figure 7. However, the proportion of

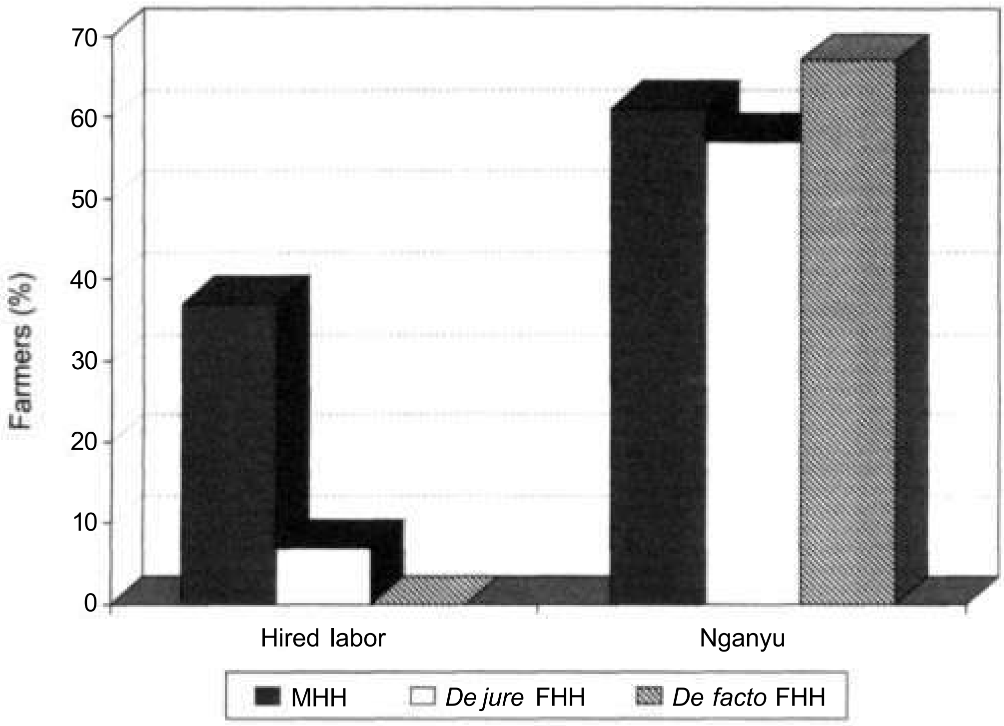

Figure 7. Labor availability based on the status of the head of household in Kasungu.

hiring labor varied significantly and was 26% for MHH, 7% for *dejure* FHH, and 6% for *de facto* FHH. The high proportion of MHH hiring labor may not be explained by high labor requirement since MHH had more full-time and part time family workers and had smaller cultivated land compared to *de jure* FHH. The proportion of households hiring labor was 32% in Kasungu, 18% in Machinga, and 10% in Dedza.

Hired labor was used for incorporating plant residue in the soil, ridge making, planting, weeding, and harvesting. However, hired labor was mainly used for ridge making (41%) and weeding (75%). This indicates that the demand for labor for two activities exceeded available family labor in most households. Majority of households hiring labor for ridge making and weeding engaged workers for 1 to 6 days.

Livestock ownership

Livestock owned were mainly small animals like chicken, sheep, and goats. Only a few households (5%) had cattle, with 6% of MHH and 3% *of de jure* FHH owning them. The two categories of households owned an average of 5 cattle per household. About half of the households had sheep and goat but the proportion of households owning them varied significantly from 44% for MHH to 33% for *de jure* FHH and 25% for *de facto* FHH. The MHH had an average of 4 goats or sheep while both *dejure* and *defacto* FHH had an average of 3. The percentage owning

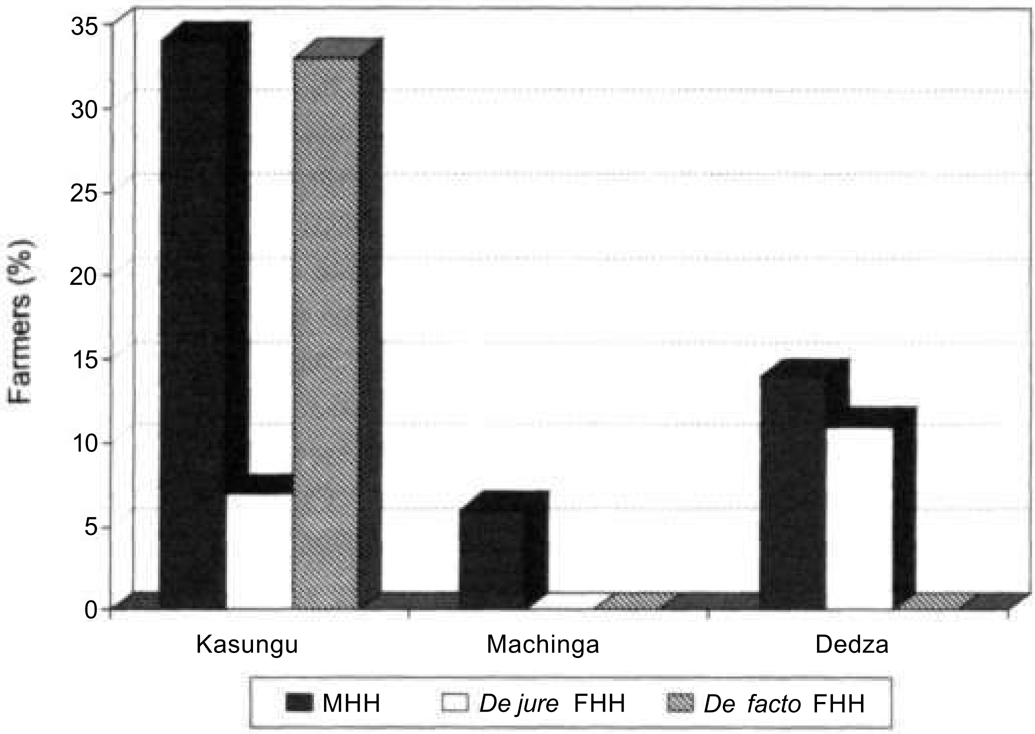

Figure 8. Percentage of farmers purchasing chemical fertilizers in different household categories at three locations in Malawi.

sheep or goat decreased significantly from 52% in Kasungu to 36% in Machinga and 30% in Dedza.

Majority of households in Kasungu owned chicken. However, the percentage owning chicken decreased from 82% for MHH to 79% for *dejure* FHH and 33% for *de facto* FHH. In Machinga only *de facto* FHH had more than half of the households owning chicken. More than half of the households of MHH and *de facto* FHH in Dedza owned chicken while only about 20% of the households in Kasungu and Dedza owned pigs. No household in Machinga reared pigs. On average more MHH owned livestock compared to FHH.

Current soil fertility management practices

Inorganic fertilizers

Fertilizer use was very low in the area (Fig. 8). About 31% offarmers in Kasungu, 4% in Machinga, and 12% in Dedza had used fertilizer prior to receiving starter packs. In Kasungu, about a third ofthe MHH and *de facto* FHH and only 7% of *de jure* FHH had purchased fertilizer. In Machinga where fertilizer was least used only 6% of MHH had purchased fertilizer while both *dejure* and *de facto* FHH had not purchased. In Dedza only 14% and 11 % of MHH and *de jure* FHH respectively had purchased fertilizer.

About 47% of households started buying fertilizer in 1990s while 53% started in 1980s or earlier. There were no major differences in the time different household categories started using fertilizer. Those who did not apply fertilizer gave the main reason as affordability. They said fertilizer was too expensive for them.

While fertilizer was not applied to most crops, about a third of the households surveyed said that they only applied fertilizer to maize and tobacco. In Kasungu, only 34% MHH, 7% of *de jure* FHH, and 33% of *de facto* FHH maize growers applied chemical fertilizers (Fig. 9). In Machinga only 6% of MHH applied fertilizer on maize while no FHH applied fertilizer on maize. In Dedza only 13% and 9% of MHH and FHH respectively applied fertilizer on maize.

The types of fertilizer commonly applied were NPK (mainly 23:21:0), CAN (calcium ammonium nitrate), and urea. Majority of farmers applied correct types of basal (75%) and top dressing (58%) fertilizers. Only about 25% applied CAN or urea as basal fertilizer while 42% applied NPK as topdressing fertilizer. The few *de facto* FHH using fertilizer applied the correct basal and topdressing fertilizer. However, the *de jure* FHH applied the wrong topdressing fertilizer. Farmers used Dollop method of top dressing fertilizer.

On average the few farmers who applied fertilizer used lower than recommended rate per ha (recommendation applicable to Malawi) (Fig. 10). However, farmers in Kasungu applied more nutrients than in Machinga and Dedza. MHH applied more fertilizer on maize than the *de facto* FHH in Kasungu while in

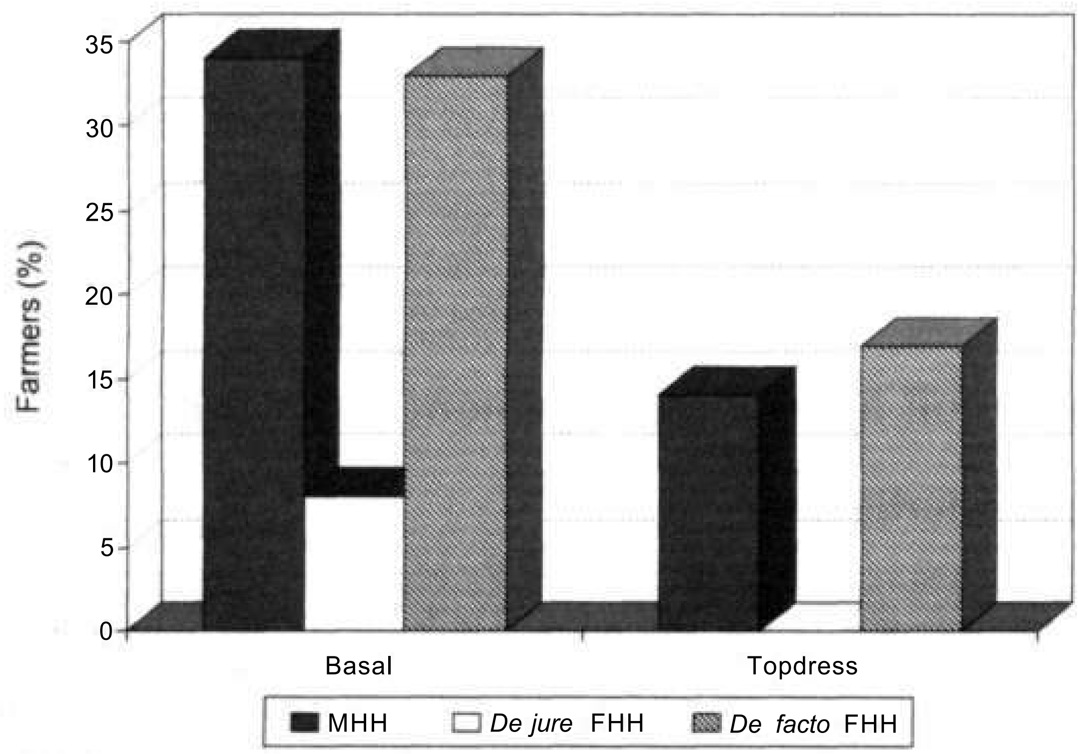

Figure 9. Fertilizer use for maize crop by different household categories in Kasungu.

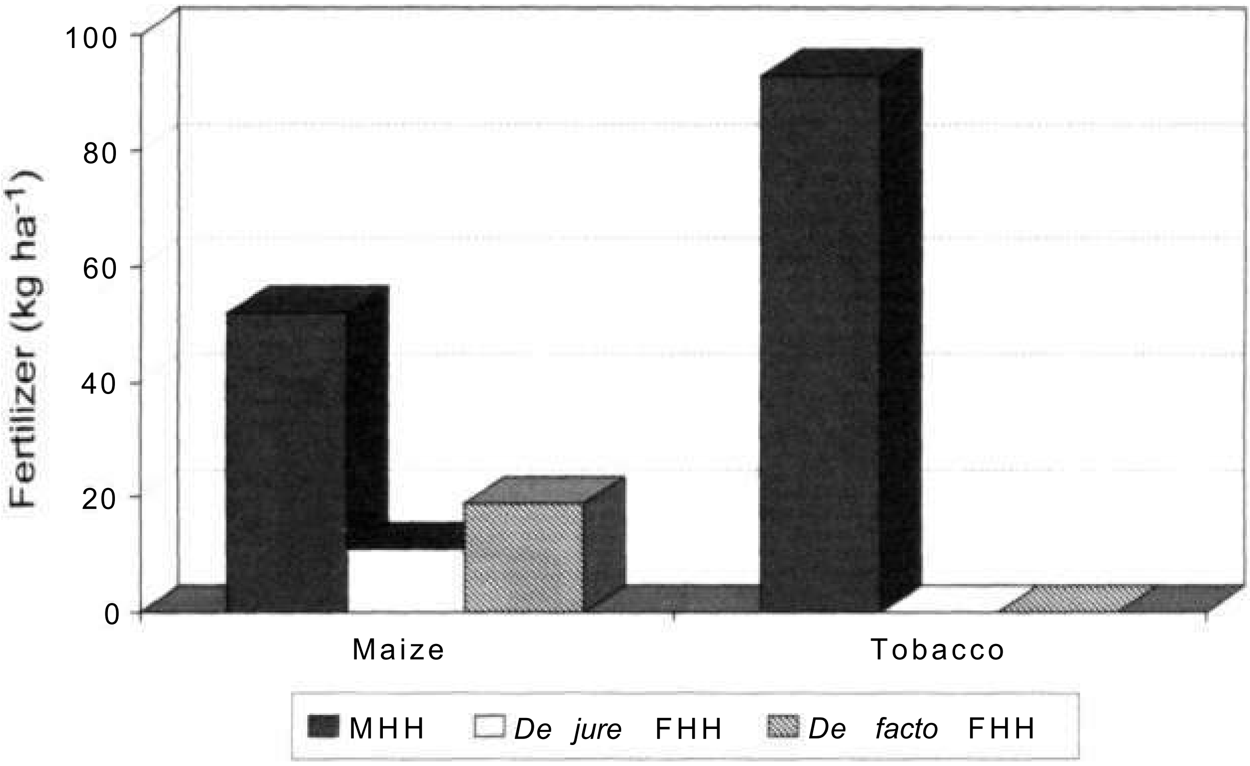

Figure 10. Amount of fertilizer applied by different household categories in Kasungu.

Dedza, *de jure* FHH applied more nutrients than MHH. On average, households applied less nutrients when top dressing maize. However, FHH rarely top dressed maize and the two that top dressed in Kasungu and Dedza applied less than 6 kg ha^{-1} . On average, the nutrients applied on tobacco in Kasungu was higher than that applied on maize.

Organic fertilizers

Organic manure is a major source of nutrients for maize and tobacco crops. The percentage of farmers using it was 35% for MHH, 33% for *de jure* FHH, and 25% for *de facto* FHH. The percentage of households applying manure was 29% in Machinga, 34% in Kasungu, and 39% in Dedza. Compost and maize and legume residues were other sources of nutrients used by fewer households. However, compost was relatively important in Dedza where about 34% of farmers used it. A small proportion of farmers in Kasungu also used soils from anthill to improve soil fertility.

Crop residues

Crop residues on decomposition are important sources of nutrients to the growing crops. Farmers mainly use crop residues to both protect soils from erosion and also

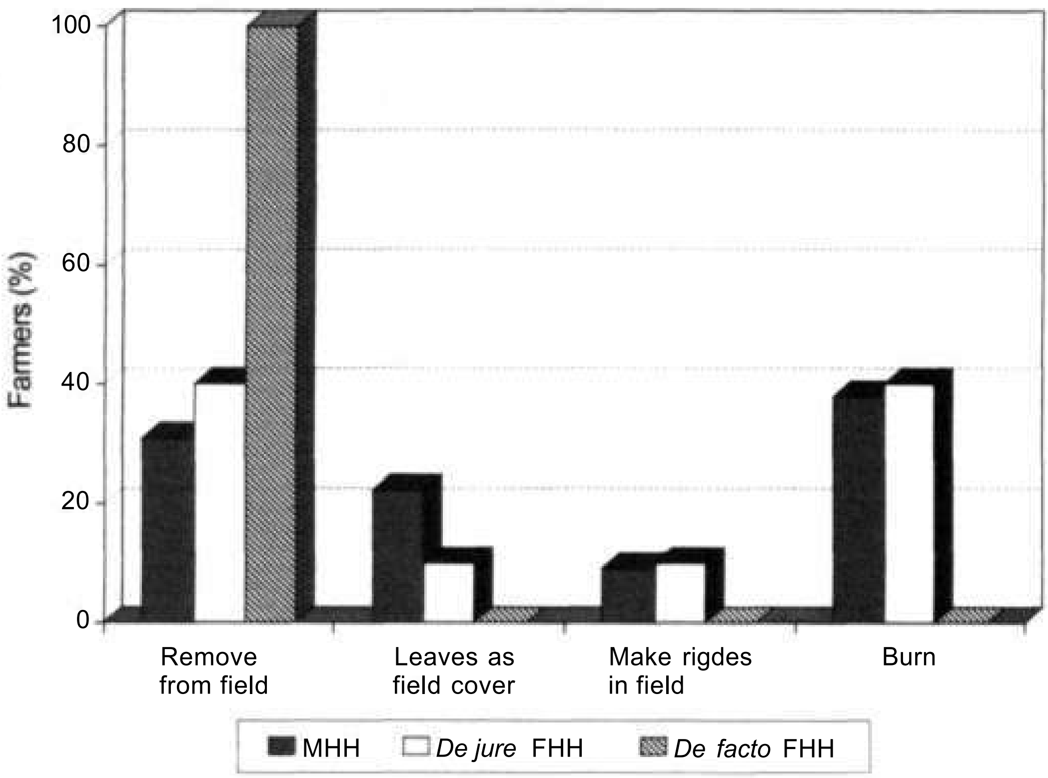

Figure 11. Management of groundnut residues in Kasungu by different household categories.

act as source of nutrients. In the sample farms, residues were either spread on the field as mulch or incorporated during ridge making, after which they decomposed and released nutrients.

Of the households surveyed, 25% used maize residues as a mulch, 1% used it to make ridges, 41% burnt it in the field, and the remaining 33% removed it from the field and fed it to livestock. This suggests that for most of the households, the nutrients contained within the maize residues were not returned to the soil. In Kasungu and Machinga majority of all households either removed maize residues from the farm or burnt it. However, in Dedza 50% of *de facto* FHH left maize residues in the field while the other half burnt it. Similar management patterns were observed for groundnut residue (Fig. 11).

Credit

Although agricultural credit is important in enhancing productivity and technology uptake, relatively few farmers (29%) reported having used credit. Only 15% had obtained credit from formal sources such as Agricultural Development and Marketing Commission (ADMARC), farmers' financing cooperation, and government. About 18% of MHH, 7% of *de jure* FHH, and 19% of *de facto* FHH had obtained credit from formal sources. The informal sources of credit were particularly important for MHH in Kasungu where 51% of them had used it.

Household decision-making

Decision-making process is critical in adoption of agricultural technologies because it influences the choice of technology and speed of adoption. In most households, decisions on production and marketing of crops may be made by different parties who have conflicting interests (Fig. 12). In *de jure* FHH, where the household is headed by the female member by virtue of her being widowed, divorced, separated, or unmarried, no conflict is expected. However, in a family where the husband and wife are working together in a farm, a conflict may arise during decision-making process. Therefore, decision-making concerns are centered on MHH and *de facto* FHH.

Decisions of activities such as ridge making, and fertilizer and manure management in Kasungu and Machinga were mainly done my husbands in MHH while for *de facto* FHH wives mainly made the decisions (Fig. 12). There was more consultation between husbands and wives of MHH in Dedza. In Dedza both husband and wife made decisions on soil fertility and marketing of maize and groundnut in 38-50% of MHH. However, for marketing of maize and tobacco in Kasungu, husbands predominantly made decisions (Fig. 12). For *de facto* FHH wives mainly made decisions for both soil fertility and marketing of maize, groundnut, and cotton. However, for tobacco which was considered to be a man's crop and a major cash crop, husbands made decisions for 50% of the households.

Summary

- More than half of the households were poor as indicated by the proportion of households that provided *ganyu* workers and with food deficit.
- Maize was mainly produced for home consumption with only few households selling for cash.
- High proportion of MHH hired labor compared to FHH.
- MHH owned more land and livestock than the FHH.
- Tobacco growing concentrated in Kasungu and was mainly grown by MHH.
- Legume growing was more important in Dedza than in Kasungu and Machinga.
- Fertilizer adoption was low with only a third of maize and tobacco growers applying fertilizer.
- Nutrient mining through burning of residues or removal of crop residues from field was prevalent in the area.
- Very few farmers had used agricultural credit.
- Husbands were main decision makers in marketing of cash crops.

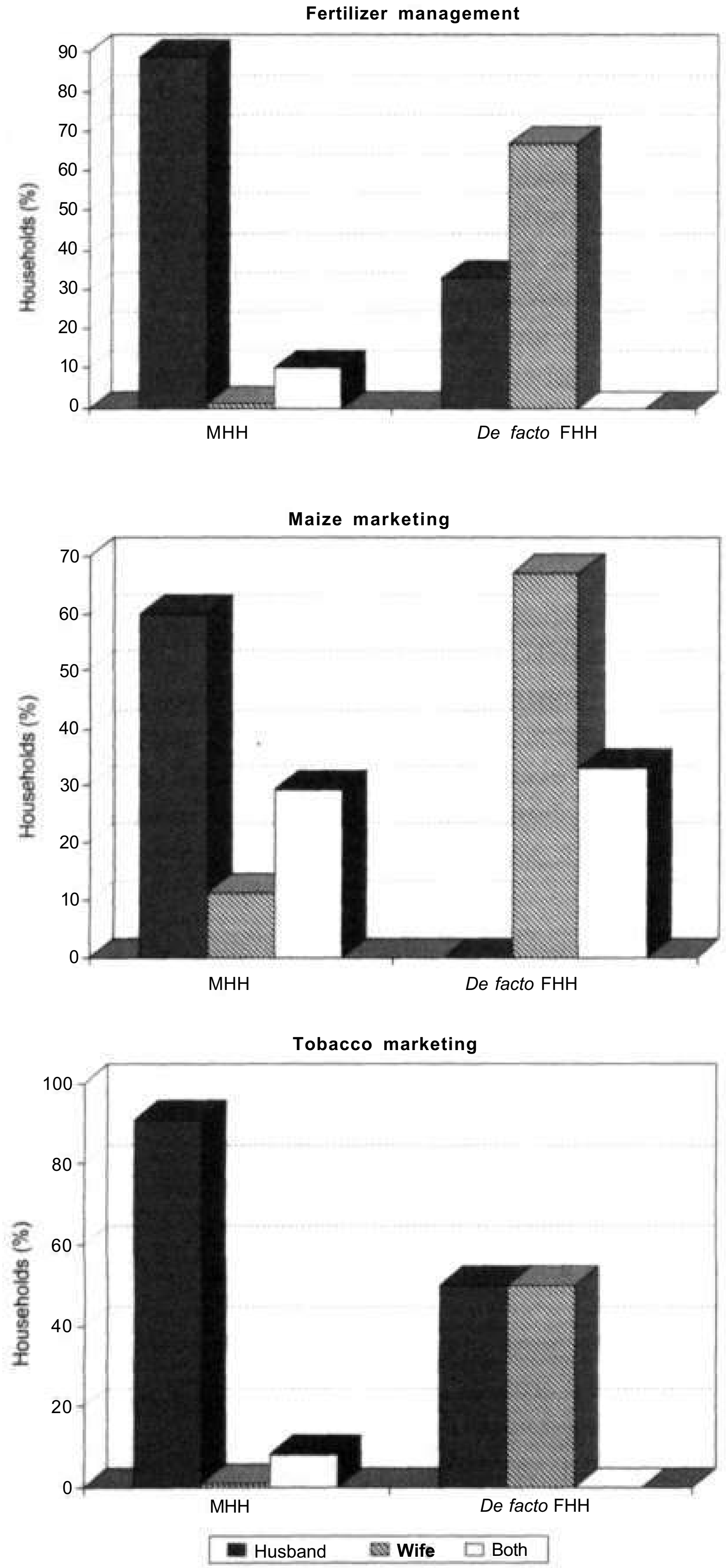

Figure 12. Household decision-making in Kasungu.

2.4 Discussion on Baseline Surveys - What Comparisons Can We Make Between the Areas?

Joseph Rusike[1] (*facilitator*)

The facilitator opened the discussion by raising the following questions:

- Is there correlation between gender and access to resources?
- Is there a need to focus on women?
- Economists tend to accept the status quo given the current power structures. Is there a need to change these? Is there a need to focus more on how decisions are made?

The discussions on the baselines were mainly based on the questions raised by the facilitator.

- The project is about developing options; hence, there was a need for an inventory of practices and options in Malawi.
- Generally farmers consider soil fertility in terms of food security. This was the most important issue in Chisepo.
- Conflicts arose, as researchers were advocating for tephrosia and *Mucuna* for soil fertility that only gave benefits after a long time, while farmers want food security in each season. What is needed is to develop a framework.
- There is a need to determine who makes decisions.
- The results of investment allocation are complicated when it comes to benefits versus food security and who makes decisions.
- There is a need for gender analysis to focus on decision-making.
- The project implementation phase did not capture the issue of decisions in terms of male versus female.
- There is a pressing need for the project to look at this issue over the next season.
- The Zimbabwe presentations showed that there are differences between drier and wetter regions in terms of female-headed and male-headed households.
- In drier parts of Zimbabwe *de facto* female-headed households have a lot of income, which was not invested in cropping. How can research intervene or interact?
- In the wetter zones of the country wealth ranking was emphasized in the baselines, but it was not clear whether poor and well-off households were relevant in the research since males were found to be part of the decision-making process.

1. ICRISAT-Bulawayo. P 0 Box 776, Bulawayo, Zimbabwe.

The issue of migration into South Africa was mentioned as one scenario that could lead to bias in the research. There is great opportunity to standardize the research through rapid rural appraisals and participatory rural appraisals. Three surveys were being compared and in these certain population groups (women) were targeted. Another way of reducing bias would be to target crops that are grown by women. It was also mentioned that rural to urban migration in other parts of the country had the same effects as migration to South Africa.

3. Malawi Presentations

3.1 Dedza (Malawi)

Jacob Mapemba[1]

ICRISAT has been conducting soil fertility management trials in Bembeke Extension Project Area (EPA) since 1997 in Kantchito, Juwa, and Kantande villages in Malawi. Five farmers were involved in the 1997/98 trials. However, information available on effectiveness of farmer-led versus researcher-led methods was found to be limited. In 1998, ICRISAT signed a Project Memorandum with DFID. The project "Improving Soil Management Options for Women Farmers in Malawi and Zimbabwe" gave researchers the opportunity to develop improved soil fertility management options in partnership with women farmers, through rigorous, formal comparison of farmer participatory research methods. During 1998/99, 23 farmers were involved in best bet trials. In 1999, ICRISAT formed partnership with Concern Universal, Malawi to develop soil fertility management options with farmers in Bembeke EPA. In May 1999, the Programme Manager and Research Officer from Concern Universal participated in the Regional Workshop on the Launching of the DFID-supported Project "Will women farmers invest in improving their soil fertility management? Participatory experimentation in a risky environment". The progress report for 1999/2000 is presented.

Participatory rural appraisal

In November 1999, Concern Universal in partnership with ICRISAT conducted participatory rural appraisals (PRAs) in three villages (Kulemeka, Gonthi, Ng'ona). The objectives of the PRA exercise were:

- Evaluate farmer perceptions of institutions, extension services, and other farm advisors.
- Gather qualitative information regarding community assessment of wealth and gendered access to natural resources.
- Identify soil and crop practices.
- Identify labor constraints and opportunities.
- Determine farm and off-farm investments and decision-making.
- Identify level of decision-making on soil management.
- Identify current services of information about crop and soil management.

The results of the PRA exercise revealed the following:

- Common crops are maize, beans, soybean, groundnut, Irish potato, and vegetables.

1. Concern Universal, P 0 Box 217, Dedza, Malawi.

- Common soils are sand, red soils (*Katondo*), sandy loam, and clay.
- Traditionally, the area follows matrilineal type of marriages. As a result, land is owned by the women who inherit it from their parents.
- The proportion of female-headed households in Ng'ona, Gonthi, and Kulemeka villages is 23.6%, 16.7%, and 47.1% respectively. Therefore, Kulemeka village has the highest number of female-headed households.
  - Mean average household size is 5.0 with a land holding size of 0.8 ha.
  - About 64.2% of the male-headed households and 83.2% of the female-headed households are in the categories of poor and poorest. Hence, the majority of female-headed households are either poor or poorest.
  - The majority of the households are subsistent farmers. Only 6% of the male-headed households are commercial farmers,
- Most of the soils are degraded and loss of soil fertility is a major problem. The major causes of low soil fertility are:
  - soil erosion
  - steep slopes
  - deforestation
  - monocropping
  - high prices of fertilizer
  - inadequate knowledge on compost making
- Very few households (6.5%) use agroforestry technologies. Low adoption rate of technologies is associated with land shortage, labor shortage, and inadequate resources such as seed and poor extension services.
- About 23.3% and 8.6% of male- and female-headed households respectively use fertilizer. In addition, 41.9% and 31.5% male- and female-headed households respectively use manure.
- Leguminous test crops such as *Mucuna* and pigeonpea have never been grown in the area prior to the collaborative work between Concern Universal and ICRTSAT.

Soil fertility

Suggested options for improving soil fertility are:

- Use of manure
- Agroforestry
- Afforestation
- Use of vetiver
- Use of contour ridges
- Incorporation of crop residues

Some of these options require resources such as livestock manure, seeds, and extension advice.

Best bet trials

During 1999/2000 growing season, 44 farmers were involved in the best bet trials. Farmer-led farmer-managed trials were conducted in Juwa and Kulemeka villages.

In Kulemeka, 12 farmers (30% women) conducted the trials for the first time. The farmers were given agroforestry seed species (*Mucuna,* soybean, pigeonpea, and tephrosia) of their choice. All farmers grew *Mucuna* as a pure stand. The rest of the crops were intercropped with maize. The average size of most of the plots was 10 ridges, each ridge 10 m long. Seed distribution was done in January 2000; hence, the crops did not perform well. The farmers would like to repeat the trials during the 2000/01 growing season.

In Juwa village, 7 farmers (48% women) were given agroforestry seed *(Mucuna,* soybean, pigeonpea, and tephrosia) of their choice to be planted during 1998/99 growing season. In 1999/2000, the farmers evaluated the performance of maize grown on plots where crop residues of *Mucuna,* soybean, pigeonpea, and tephrosia were incorporated. The biomass was incorporated between July and October 1999. Ridging was done in October to November 1999. Trials were planted in December 1999.

Researcher-led farmer-managed baby trials (pure or intercrops of *Mucuna,* soybean, tephrosia, and pigeonpea) were conducted in Kantande and Kantchito villages. The sizes of the plots were 8 ridges, each ridge 7.2 m long. Twenty-four farmers were involved in the trials. Of these, eight farmers conducted manure trials. Germination of soybean, maize, and *Mucuna* was very good. Pigeonpea had poor germination because weevils damaged the seed. Due to late incorporation of crop residues combined with cold weather in Bembeke EPA, crop residues were not fully decomposed by the time of planting. Hence, about 3 kg of fertilizer was required at planting time.

The major soil fertility management options in all the eight villages were:

- Maize plots with manure and fertilizer
- Maize plots with *Mucuna*
- Maize plots with fertilizer
- Maize rotated with pigeonpea
- Maize plots with manure
- Maize rotated with tephrosia
- Maize plots without any intervention
- Mother and baby plots with soybean, pigeonpea, tephrosia, and *Mucuna.*

Results of best bet trials and farmers' perceptions

- Farmers' observations on the relative performance ofbest bet baby trials showed that farmers are mostly interested in technology options that combine organic inputs with small amounts of fertilizer.
- Preliminary results of the soil fertility management options show an increase in maize yield of 36-79%.
- Maize yields ranged from 1.0 t ha^{-1} to 1.8 t ha^{-1} in plots with different soil fertility management options.
- Maize plots with manure and fertilihzer gave the highest maize yield followed by maize after *Mucuna* and maize plots with fertilizer.
- Goats destroyed most of the pigeonpea plots; hence, there was no biomass to incorporate into the soil.
- Traditionally, the farmers in the area do not consume *Mucuna;* hence, there is need to find market. The enumerator is currently gathering information on the quantity of *Mucuna* that farmers want to sell so that market can be sought.
- Farmers feel compost manure with livestock manure has more nutritive value than crop residues only. Hence, farmers requested the project to provide livestock.
- On 8 March 2000, ICRISAT, Concern Universal, and Chitedze Research Station organized a field day. Eight farmers (including 13 from Lobi, Kabwazi, and Linthipe EPAs) attended the field day. The Catholic Development Commission (CADECOM) also attended the field day. During the field day farmers were taken to plots:
  - Where *Tithonia* was incorporated at: 1.51 ha^{-1},3.0 t ha^{-1}, and 4.0 t ha^{-1}. Farmers were impressed with the performance of maize with *Tithonia* at 4.0 t ha^{-1}.
  - Where maize was rotated with *Mucuna,* pigeonpea, beans, tephrosia, and soybean. Farmers ranked the performance of maize as follows: *Mucuna,* pigeonpea, soybean, and tephrosia. However, farmers expressed the concern that people in the area do not consume *Mucuna* seed and therefore, there was need to find market. It was suggested that the seed could be sold to markets in the Southern Region where people consume *Mucuna* seed. Pigeonpea suffers from damage by goats. Results at Bembeke Research Station revealed that *Mucuna,* tephrosia, and soybean contribute 80 kg, 60 kg, and 20 kg of nitrogen ha^{-1} respectively. There is need therefore to do pair-wise ranking involving farmers, researchers, and extensionists. The results of the pair-wise ranking have been completed and await analysis.

Training for transformation

In May 2000, Concern Universal conducted Training for Transformation for the 12 farmers in Kulemeka village. Topics covered were:

- Introduction to Training for Transformation
- Development (Liberator Code, River Code, Maslow's Ladder of Development)
- Problem identification and solving
- Participation in relation to development
- Committees
- Leadership
- Conflict resolution
- Monitoring and evaluation

At the end of the training, a committee was formed. In addition, an action plan was drawn by the farmers (Table 1).

Table 1. Action plan drawn by the farmers.

Activity	Responsible person	Time	Resources
Committee meeting	Chairman	23 May 2000	Minutes
Village meeting	Committee members	27 May 2000	Minutes
Training on manure making	Farmers and extension worker	Jun 2000	Training materials
Making manure	Farmers	Jun 2000	Training material
Incorporation of residues	Farmers	Jul 2000	
Meeting to decide on agroforestry species to be grown during 2000/01	Committee members, farmers, extension worker	Jul 2000	
Contour ridging and ridge alignment	Farmers	Jul 2000	A-Frame
Manure application	Farmers	Sep 2000	Manure; labor
Seed distribution	Committee members, extension worker	Oct 2000	Seed
Planting of seed	Farmers	First rains	Seed; labor

When the farmers addressed a village meeting, 14 additional farmers joined the group. Hence, the group has now 26 members. Training on manure making was conducted as planned and 26 farmers have made one heap of compost manure each. Farmers are being encouraged to make more heaps. Currently, the farmers are doing ridge alignment in their fields using A-Frame. The effects of manure management on crop performance will be evaluated during the 2000/01 season.

3.2 Chisepo (Malawi)

Bernard Kamanga[1]

Will women farmers invest in soil management options? To address this question a number of other questions must be answered.

- Can research development do a better job of helping women farmers adopt and adapt to a constantly changing world?
- Can research help farmers in general and women in particular gain sustainable access to food so that they can go beyond mere survival and towards sustainable livelihoods?
- What activities do women normally carry out that govern management decisions on soil improving strategies?
- How does comparing technology development approaches affect women farmers in investing in soil improving technologies?

Most soils in Malawi are infertile and need fertilizer additions if they are to produce food. Because of this problem, farmers especially women are producing quite low crop yields. The questions above point at the complexity of the soil fertility problem and whether solutions could be identified to reverse the situation. This problem calls for diversity in thinking to design many ways of working towards such ambitions at different levels and geographical locations. This paper outlines initial results of the work on comparative methodological approaches on achieving women involvement in technologies that improve soil fertility. The work focuses on whether the approaches would:

- Improve sustainable access to food.
- Suit the resource endowment of the farmers in different localities.
- Minimize trade offs among productivity, sustainability, stability, and equity objectives.
- Help in scaling up of technologies that farmers experiment on.
- Give institutions that are already using them in the field a strong interest in going beyond their present commitment.
- Assist in coming up with good future vision for women farmer in soil improving technologies.

This paper gives a summary of the work carried out during the 1999/2000 season and includes a brief statement on the layout of the trials, data collection, and lessons learned from the trials and also outlines future activities.

1. CIMMYT-Malawi, Bunda College of Agriculture, PO Box 219, Lilongwe, Malawi.

Project protocol

The project started in 1999/2000 growing season with two sites in Malawi. The first site is in Dedza under Concern Universal. The initial results of the second site Chisepo are reported in this paper. Chisepo is in the relatively dry, mid-altitude Kasungu plains that extend to the northern region of Malawi. The annual rainfall is about 875 mm with mean temperatures of 18°C. The area has a high level food insecurity and malnutrition. About 90% of the farmers produce a commercial tobacco crop with little inorganic fertilizers on small plots.

Four villages are targeted in this work with each village having ten farmers. The villages are Bwemba-Kamasese in Santhe, Mbingwa, Kamphenga, and Chisepo proper. Bwemba-Kamasese is a control village; Mbingwa hosts researcher-designed, farmer-managed trials; Kamphenga has demonstration trials while Chisepo has farmer-led trials. All the trials in the three test villages focus on legumes (pigeonpea, groundnut, and tephrosia) in rotations with and or intercropped with maize with no or little fertilizer in the first year. With the exception of Mbingwa, the trials are in their first year and maize has not benefited a lot from the legume association.

The control village

The control village acts as a check against the three approaches in the other villages. No interventions were designed for this site except for the baseline survey to characterize farmers. However, periodically similar surveys would be carried out to update the information to see if any of the technologies in the other villages are taken up through farmer to farmer extension.

Demonstration village

Trials of this nature serve the purpose of demonstrating to the farmers recommendations that they should implement. Legume rotation and intercropping are current soil improving options that are showing high returns for those using them and also contributing significantly to the resource-poor households' safety nets. In this site the field staff work closely with farmers to facilitate activities of the demonstration. Frequent field visits, field days, and group panels are used to demonstrate the performance of the trials so that farmers can see the impact.

Researcher-led village

These trials followed the mother-baby approach where all treatments are set on one farm with replicates within the farm. The mother trials are managed by the researcher with some assistance from the host farmers. The baby trials are satellite trials located in farmers' fields with a collection of treatments that the host farmers have chosen to test. Farmers are replicates in this case and it is intended that the farmer fully manage the trials on their own. Inputs are provided to the farmers. The researcher and the farmer assess the performance with great emphasis on what the farmers decide on.

Farmer-led village

Farmers experiment with what they think is worth trying based on available resources with researchers facilitating the processes. Farmers learn through training for transformation where activities for learning and experimentation are the responsibility of the farmer. Farmers buy their own resources such as fertilizers and seed. In this case provision of the resources was made by the researcher, and the decision on how to plant and manage the fields was the responsibility of the collaborating farmers. The researcher just observes the processes involved in the trial so as to process the data.

Farmer selection, trial design, and data collection

Soil infertility is the most critical issue in smallholder agriculture today. Women are most affected as it is their households that are most frequently in food deficit. The trials were designed to take into account the need to improve soil fertility using the legumes that at the same time also provide diversity in food consumption. Before the trials were implemented, a survey was conducted to characterize the farmers and selection was based on the results of the survey. Random sampling was used in the two villages where the trials were in the first year. Each farmer had five plots 10 m x 10 m. Agronomic data was collected from a net plot of 54 m^2. Details of how the technologies were implemented are shown in Table 1. Two sets of data were collected. Minimum agronomic data sets include soil sampling for nitrogen status, texture, soil pH, and phosphorus status; and crop performance as measured by grain yield and harvest indices. Socioeconomic data included labor required in the activities in the year for each approach, farmer perceptions on the performance of the trials, resource allocation maps, and constraints and opportunities as identified by farmers on the approaches. This information was collected by using participatory rural appraisal (PRA) techniques and organizing formal field days.

Initial results

Participatory rural appraisal

In this exercise, emphasis was on characterizing the farming households in the area. Some of the results are summarized in Table 2. Only 10% of the households

Table 1. Farmer perceptions of soil fertility improving technologies.			
Technology	Population density	Biological characteristics	Farmer perceptions
Maize control	Maize: 37,000	Maize hybrid MH 18, three maize plants per planting station, 0.9 m x 0.9 m	Current farmer practice throughout Malawi.
Maize with fertilizer	Maize: 37,000	Maize hybrid MH 18, three seeds per station.	Use little fertilizer (17 kg ha^{-1}) as it is costly. Abundant yields.
Maize + pigeonpea intercrop	Maize: 37,000; pigeonpea: 37,000	Temporal compatibility. Pigeonpea variety ICP 9145 planted at the same time as maize, 3 plants per planting station spaced halfway between each maize station. Pigeonpea grows slowly, which reduces competitor with maize.	Pigeonpea is a bonus crop. Low density system minimizes impact on maize yields.
Groundnut + pigeonpea intercrop in year 1 and rotation with maize in year 2	Groundnut: 74,000; pigeonpea: 37,000	Groundnut variety JL 24 or CG 7 was grown as a single row on ridges spaced at 0.9 m. To enhance residue biomass quantity and quality, a 'bonus' pigeonpea crop is intercropped with the short-duration grain legume.	Legume seed density takes into account expense of groundnut seed and farmer-adoptable seeding rates. Pigeonpea is a bonus crop.
Maize + tephrosia relay intercrop	Tephrosia: 20 kg ha^{-1}; maize: 37,000	Temporal compatibility enhanced by planting tephrosia at 1st weeding. Tephrosia has an initially slow growth habit. Green manure screening studies have shown the wide-spread adaptability of tephrosia to Malawi agro-ecosystems, producing about 2 t ha^{-1} as a relay intercrop.	For a green manure system to be adopted by farmers, it must minimize labor required. Seed is broadcast along ridge and then incorporated by weeding operation.

are female headed and the rest male headed. Results in Table 2 show that female-headed households experience more constraints than male-headed households as indicated by landholding size, average yield, and consumer/worker ratio which indicates labor supply. These households do not hire labor and hence face more production constraints.

Table 2. Household characteristics of the three household types[1].

Characteristic	*De jure* FHH	*De facto* FHH	MHH
Type of household (%)	8.0	2.3	89.7
Landholding size (ha)	1.2	1.5	2.9
Crops grown (%)			
Maize	47.6	12.8	57
Tobacco	9.1	5.6	43
Groundnut	21.6	12.9	9.0
Legumes	4.1	0.5	0.1
Average maize yield (kg ha^{-1})	671	796	817
Consumer/worker ratio	1.5	1.1	0.9
Hire labor (%)	0	0.6	29
Livestock ownership (%)	15	6	43
Knowledge of legumes (%)	72	17	94
Use of legumes (%)	19	5	13

1. FHH = female-headed households; MHH = male-headed households.

Trial performance

Performance as measured by yield of maize is shown in Table 3. Legume intercropping or rotations had little influence on the performance of maize in the first year. Maize yields (P = 0.001) were high in the researcher-led village followed by the demonstration village and least in the farmer-led village. The trends show that the researcher-led approach was superior but under these circumstances comparison is not uniform. Differences in field management are an issue to support the variations in maize yield. For example, the researcher-led trials have been in the field for two years now and higher yields might indicate the effect of legumes on soil fertility. Legume biomass was incorporated in the first year and this improved soil fertility through nitrogen fixation and decomposition of litter for the maize to show response. Maize yield from the technologies determines whether the farmers would achieve the goal of food sufficiency that influences the choice of the technologies.

Table 3. Trial performance as indicated by maize yield (kg ha^{-1}).			
Treatment	Researcher-led	Demonstration	Farmer-led
Maize control	699.5	661.1	990
Maize with fertilizer	2226.9	2022.5	2224
Maize + pigeonpea	1584.6	1059.3	925.9
Groundnut + pigeonpea[1]	1608.2	-	-
Maize + tephrosia	1704.5	1181.4	1097.9
Mean	1564.7	984.9	1047.6
CV (%)	36.77		
SE	132.44		

1. Intercrop in year 1 and rotation with maize in year 2 in researcher-led trials. No maize was planted in demonstration and farmer-led trials.

The researcher-led trials required more labor (Table 4). This is expected because the researcher would want to carry out all agronomic practices and the farmer would not want to let the researchers down; hence more labor is used. There were no significant differences in labor in the farmer-led and demonstration trials. Labor is one of the factors of production that influences farmers' adoption of technologies. If the technology is labor intensive, adoption is reduced.

Table 4. Labor (hours ha^{-1}) used in the systems by different approaches.			
Treatment	Farmer-led	Demonstration	Researcher-led
Maize control	713.6	447.0	467.0
Maize with fertilizer	712.8	647.2	721.0
Maize + pigeonpea	667.2	436.8	468.1
Groundnut + pigeonpea[1]	675.8	401.0	414.0
Maize + tephrosia	678.6	670.5	1413.3
Mean	689.6	520.5	696.6
CV (%)	33.91		
SE	61.57		

1. Intercrop in year 1 and rotation with maize in year 2.

Farmer perceptions and constraints

Farmers have knowledge about legumes and their contribution to soil fertility and food security (Table 5). Farmers are aware that legumes improve soil fertility, provide grain that could be sold for cash and also consumed to increase the protein intake of the households. However, production of legumes is low. Farmers indicated lack of seed, lack of markets, poor soils, livestock damage of legumes, and lack of labor as factors that limit legume production. These perceptions tune farmers' choices of which technology to incorporate in the farming systems. Farmer rating of the technologies in Mbingwa is given in Table 5. Those systems with pigeonpea were rated high in all aspects indicating that farmers prefer the technology. This information, however, does not indicate the level of preference of technologies by different classes of farmers.

Table 5. Farmer rating of technology traits in Mbingwa, Malawi[1].

Treatment	Weeding and labor requirement	Seed availability	Contribution to food security	Contribution to cash sales	Contribution to soil fertility
Maize control	3.1	3.3	2.2	2.3	1.5
Maize with fertilizer	2.9	3.3	3.2	2.7	1.2
Maize + pigeonpea	2.5	1.9	3.4	2.9	3.1
Groundnut + pigeonpea[2]	2.2	1.7	3.3	3.4	3.1
Maize + tephrosia	2.8	1.3	2.0	1.9	1.8
LSD	0.4	0.5	0.4	0.6	0.5

1. Rating: 1 = very low; 2 = low; 3 = high; 4 = very high.
2. Intercrop in year 1 and rotation with maize in year 2.

Lessons learned

The first year of the project has revealed that farmers need soil improving technologies but constraints associated with them reduce the practice. Labor is the main constraint. Therefore, an economic incentive for adoption of technologies is reduction of labor. This means that labor saving technologies have to be developed if the soil improving technologies are to be adopted. An input from farmers is essential on this issue. Another lesson learned is that the set up of the technologies limits farmer participation. Collaboration among stakeholders is difficult and more has to be done to improve it.

Future work

The project will intensify PRAs to generate more information on aspects for comparison of the approaches. Detailed labor data will be collected to examine how the approaches would affect labor supply by the households. Since this work focuses on women, there is need to look into gender. Trial design of technologies will be the same as in the first year, to build up on lessons learned.

3.3 General Discussion on Malawi Presentations

Ade Freeman[1] (*facilitator*)

A number of issues arose from the two presentations. An issue of concern from the two presenters was the logistics. Both presenters had problems of linking with the researchers.

The linkage between participatory rural appraisal (PRA) and technology testing was not clear. There were numerous technology processes at Chisepo, Malawi but these were not formally tested.

There is need to assess options and create incentives for adoption by looking at the economics of the options (trials) given and the issue of labor.

Definitions of "farmer-managed" and "researcher-led" need to be taken note of and improved in order to come up with clear approaches in experimentation next season.

1. ICRISAT-Nairobi, P O Box 39063, Nairobi, Kenya.

4. Zimbabwe Presentations

4.1 Research Results on Improving Use of Cattle Manure in Tsholotsho and Shurugwi in Zimbabwe

H K Murwira[1], K Mutiro[1], N Nhamo[1], and J K Nzuma[2]

Improved organic matter management is key to increasing productivity of soils in most communal areas of Zimbabwe. Manure is one of the organic resources available to farmers; however, ICRISAT and Tropical Soils and Biological Fertility (TSBF) surveys indicated that its use varies widely in Zimbabwe from 30% in Tsholotsho to >70% in Shurugwi. There is, therefore, need to look at ways of increasing manure use in the different areas, particularly in Tsholotsho and at the same time improving efficiency of utilization in areas where the resource is already widely made use of. The effective use of manure by smallholder farmers is limited by three major factors: (i) quality of manure; (ii) quantity of manure available; and (iii) rainfall regime.

Poor quality manure reduces yield and low quantities of available manure limit the potential yield benefit. Low rainfall in areas like Tsholotsho places a limit on the quantities of manure that can be added as local farmers often report instances of crop burn during dry spells, especially when large quantities are added.

The objective of this study was to test different methods of improving quality and effectiveness of manure and to institute a more participatory program of on-farm testing of the various options by farmers in Tsholotsho and Shurugwi.

Materials and methods

The study was conducted at two sites, Shurugwi and Tsholotsho, to evaluate the effect of different storage practices on quality and effectiveness of manure on farm. From participatory rural appraisals done during the dry season of 1999, farmers identified problems with manure use relating especially to:

- the problem of crop burn;
- lack of information on rates of application; and
- poor quality and low quantities available.

Two approaches were taken to evaluate the technologies by utilizing researcher-managed and farmer-managed trials. In researcher-managed trials, focus was on

1. TSBF, PO Box A469, Avondale, Harare, Zimbabwe.
2. DR&SS, CSRI, P 0 Box CY 550, Causeway, Harare, Zimbabwe.

assessing the technologies in somewhat greater detail using standardized agronomic practices, whereas in farmer-led trials researchers only facilitated establishment of simplified trials. Monitoring was left to the farmer until harvest when yields were jointly measured. The project benefited from prior exposure of working in Shurugwi in 1998/99 but the work in Tsholotsho was entirely new and more challenging considering the long distance from Harare.

Several researcher-managed trials were implemented and these focused on establishing the fertilizer equivalency of different types of manure, rate of application, and effects of combining pit and heap stored manure with fertilizer.

Thirteen manures (6 from Tsholotsho and 7 from Shurugwi) were evaluated for fertilizer equivalencies using a fertilizer nitrogen (N) response curve derived from applications of 0, 30, 60, 90, and 120 kg N ha^{-1}. There were 3 trials on rate of manure application in Tsholotsho with 6 treatments, viz., 0, 3, 6, 9, 12, and 15 t ha^{-1} in a completely randomized block design. The trials on combining manure with inorganic N were conducted at 4 sites in Tsholotsho and had the following treatment combinations in a completely randomized block design: manure (100%), manure (75%) + N (25%), manure (50%) + N (50%), manure (25%) + N (75%), and N (100%). All treatments received N at a rate equivalent to 60 kg N ha^{-1} in total applied either as manure only, fertilizer only, or combinations of the two in proportions indicated. There was a minimum of three replicates per treatment in all the trials.

Farmer-managed trials had very simplified designs. The trials evaluated pit vs heap stored manure (11 farmers in Shurugwi, and 6 in Tsholotsho), rates of manure application (0, 3, and 5 t ha^{-1}) on different soil types, comparing cattle and goat manure, uncovered heap vs covered heap. Individual farmers were used as replicates.

Data from the trials was analyzed using MSTATC to determine treatment differences.

Results and discussion

Rates of manure application

The effect of rate of application of manure in researcher-managed trials was significant at 2 sites out of 5 ($P<0.05$). Optimum rates of application when averaged across all sites were 3 t ha^{-1} for clay soils, 6 t ha^{-1} for clay loamy, and 9 t ha^{-1} for sandy soils (Fig. 1). Absolute manure effects were positive at all sites but not necessarily significant. In farmer-managed trials the range of treatments was narrow (0, 3, and 5 t ha^{-1}) due to little quantities of manure available; however, manure effects were significant ($P<0.05$) but there was no significant difference between the treatments 3 and 5 t ha^{-1} for cross-site data (Fig. 2).

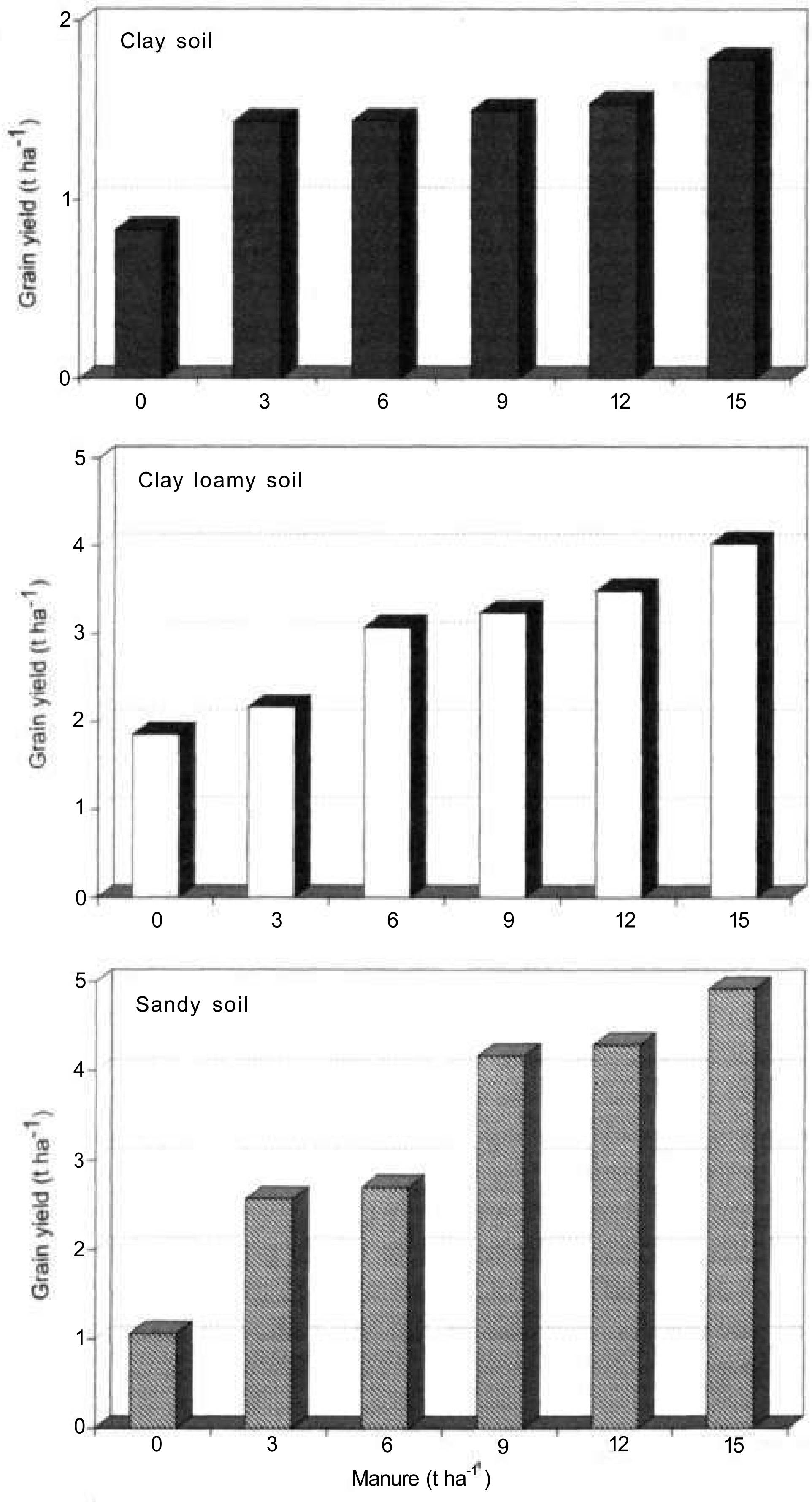

Figure 1. The effect of rate of application of cattle manure on maize grain yields on different soils in Tsholotsho, Zimbabwe.

Fertilizer equivalencies and effects of combining manure and inorganic N

The fertilizer equivalencies of the manures ranged from -30% to 60% showing that manure can mobilize or immobilize nutrients depending on its quality. An overall positive linear relationship was obtained between N content and fertilizer equivalency ($y = 82.4x - 63.114$; $R^2 = 0.5403$) (Fig. 3). The critical value for net mineralization of the manures tested was 0.75% N; however, this cannot be considered as an absolute as there are modifiers to the process such as lignin or some other factors. Fertilizer equivalencies of pit-stored manure were in all cases higher than in heap-stored manure. This is to be expected as pit storage results in anaerobic conditions, which minimize nutrient losses particularly from ammonia volatilization.

The trials evaluated both pit and heap manures and the effect of combining them with fertilizer N. There were no statistical differences among combinations for both pit and heap manures at two of the sites in Tsholotsho (Maria Moyo and Dora Msimanga). However, combination effects were significant at all other sites with yields being larger when combinations were used (Fig. 4). The hypothesis that pit stored manure will perform better than heap manure at combinations with a larger proportion of manure than fertilizer could not be sufficiently tested. This will be essential in future.

Comparison of heap and pit stored manure

The heap and pit storage treatments were evaluated in both researcher- and farmer-managed trials. Researcher-managed trials were established at 4 sites in Shurugwi using manures obtained from farmers (storage was not monitored by researchers). Overall effects of pit storage were positive but were not statistically significant ($P>0.05$) except for one site (Fig. 5). This could probably have been due to the excessive rains received. In on farmer-managed trials with eleven replicate samples in Shurugwi, yields from pit-stored manure were significantly higher than that from heap-stored manure (Fig. 6). The range of increase in maize yield as a result of using pit-stored manure was from 11% (114.8 kg ha^{-1}) to 460.2% (3092.2 kg ha^{-1}). The average yield increase due to use of pit-stored manure was 121.9% (835.4 kg ha^{-1}) across all farmers. There were four farmers who had heap and covered heap treatments. Analysis of the yield showed no significant effect of covering the heap (Fig. 7).

Economic analysis

The results of farmer participatory trials were analyzed to assess the profitability of the two different storage systems. Gross margin analysis indicated that pit storage of manure (ZW$ 7986.01 ha^{-1}) is much more profitable than heap storage

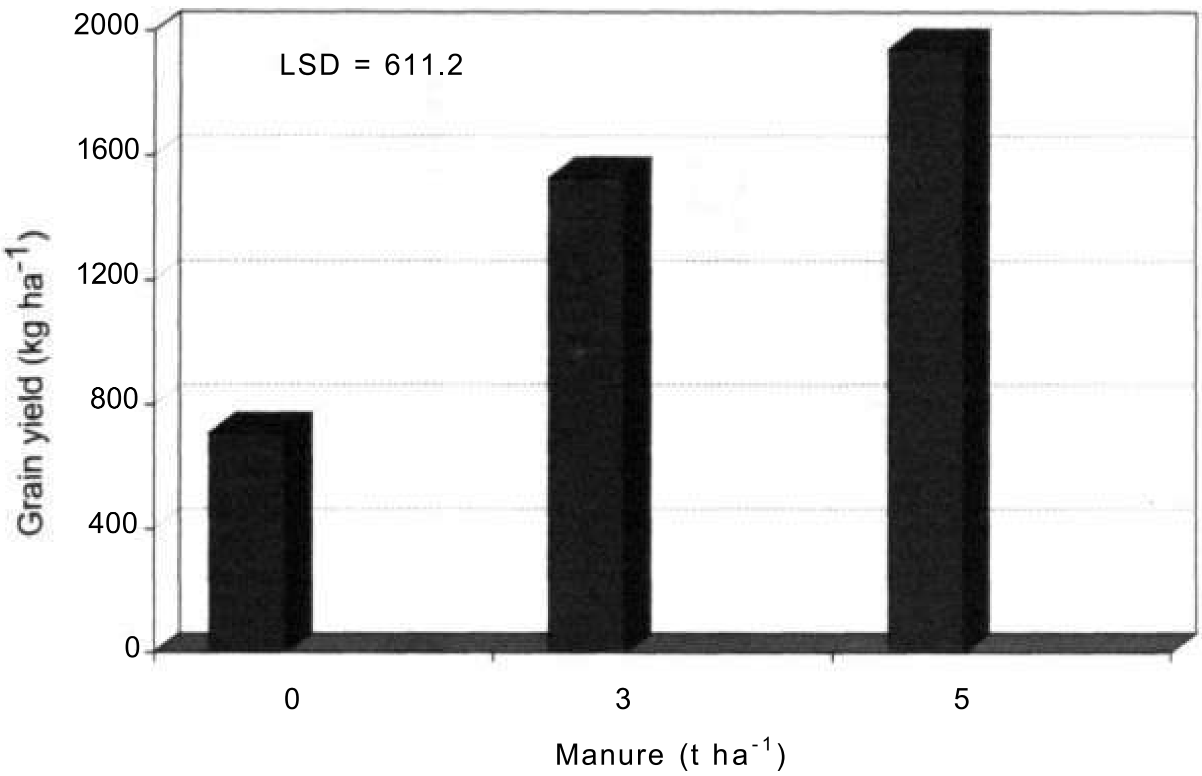

Figure 2. The effect of manure application on maize in farmer-managed trials in Zimbabwe.

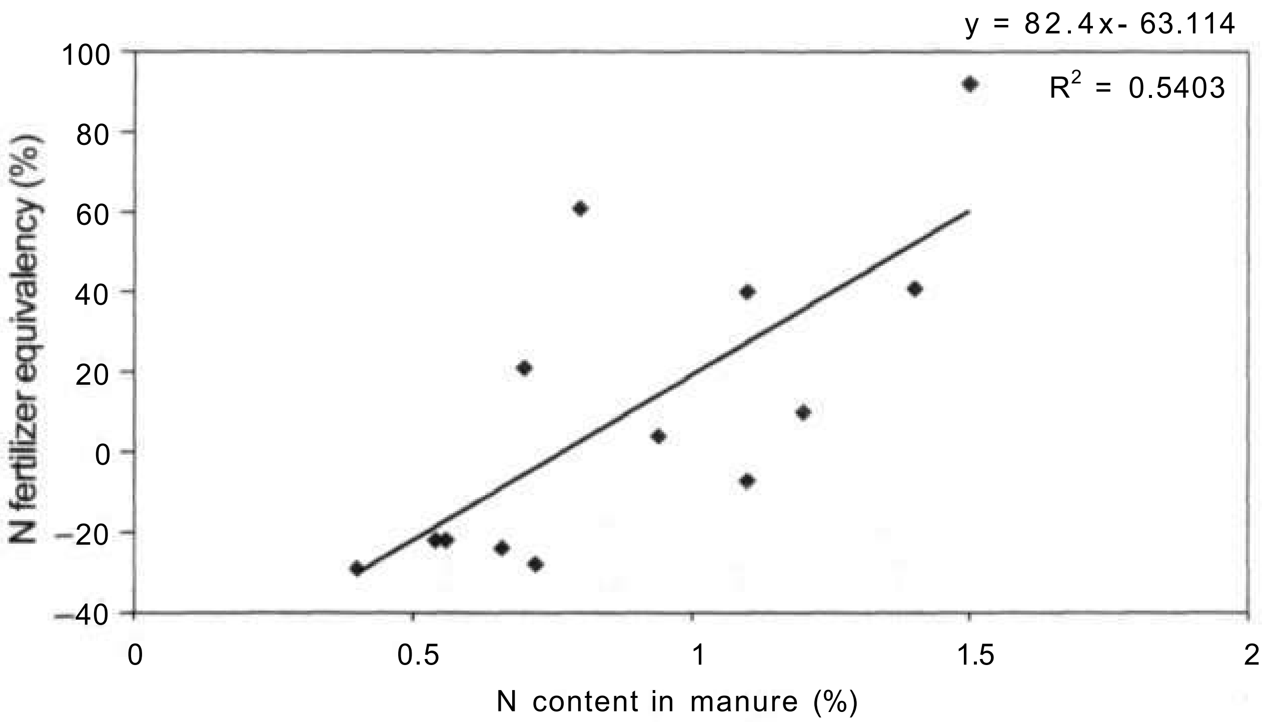

Figure 3. Relationship between nitrogen (N) fertilizer equivalencies and N content of manure in Shurugwi and Tsholotsho in Zimbabwe.

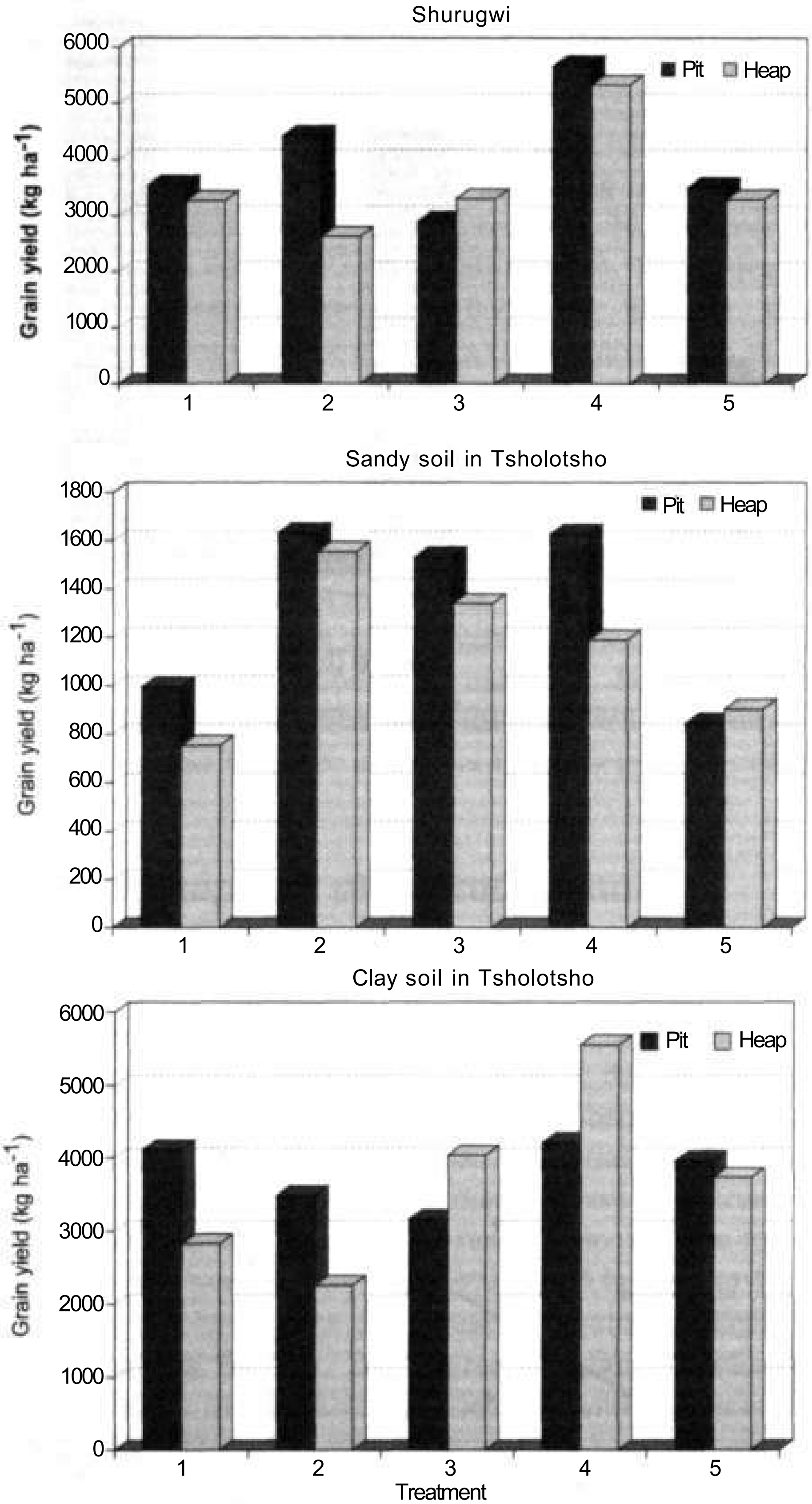

Figure 4. The effect of combining different manures and inorganic nitrogen (N) fertilizers on maize grain yields.

(Note: Treatments are: 1 = 100% manure; 2 = 75% manure + 25% inorganic fertilizer (IF); 3 = 50% manure + 50% IF; 4 = 25% manure + 75% IF; and 5 = 100% IF.)

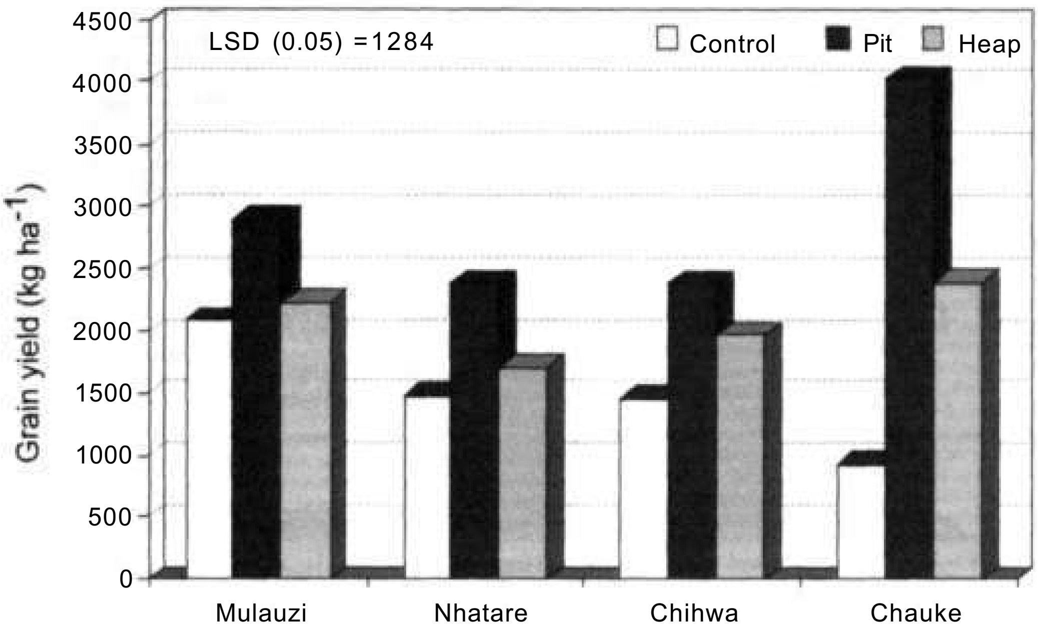

Figure 5. Mean yields of maize obtained in different farmers' fields in Shurugwi.

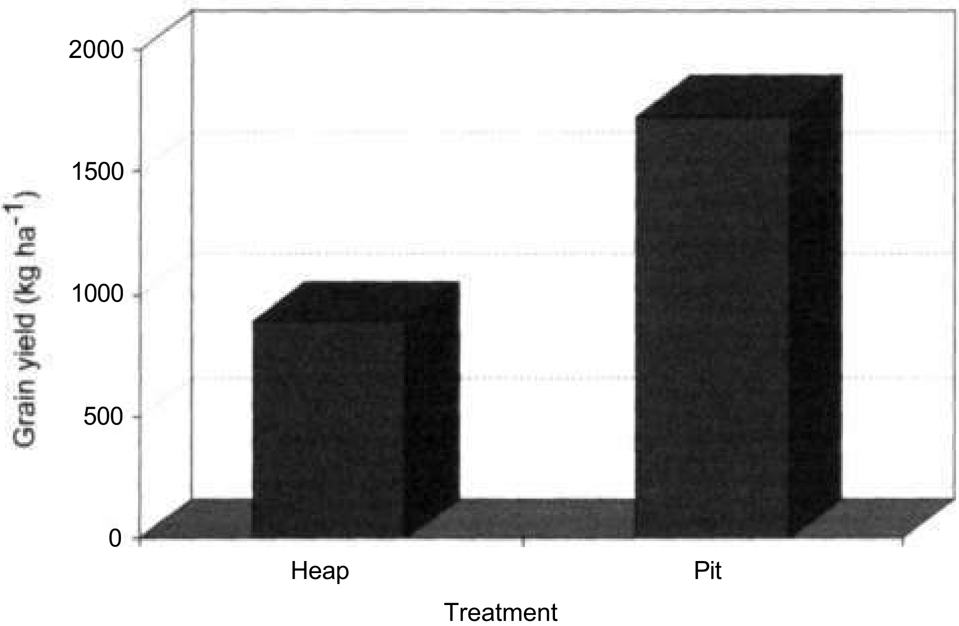

Figure 6. Comparison of heap and pit manure on maize crop in Shurugwi.

(ZW$ 471.37 ha^{-1}). Farmers who have adopted the pit technology acknowledge the large response in maize yield (3.1 t ha^{-1}) when pit-stored manure is used, when compared with heap storage (1.3 t ha^{-1}). Less than 100 kg of maize grain ha^{-1} is required to offset the cost of adopting pit storage technology. This is equivalent to ZW$ 500 at current grain prices of ZW$ 5.00 kg^{-1} of grain. More importantly the pit is dug out once and maintained only in succeeding years.

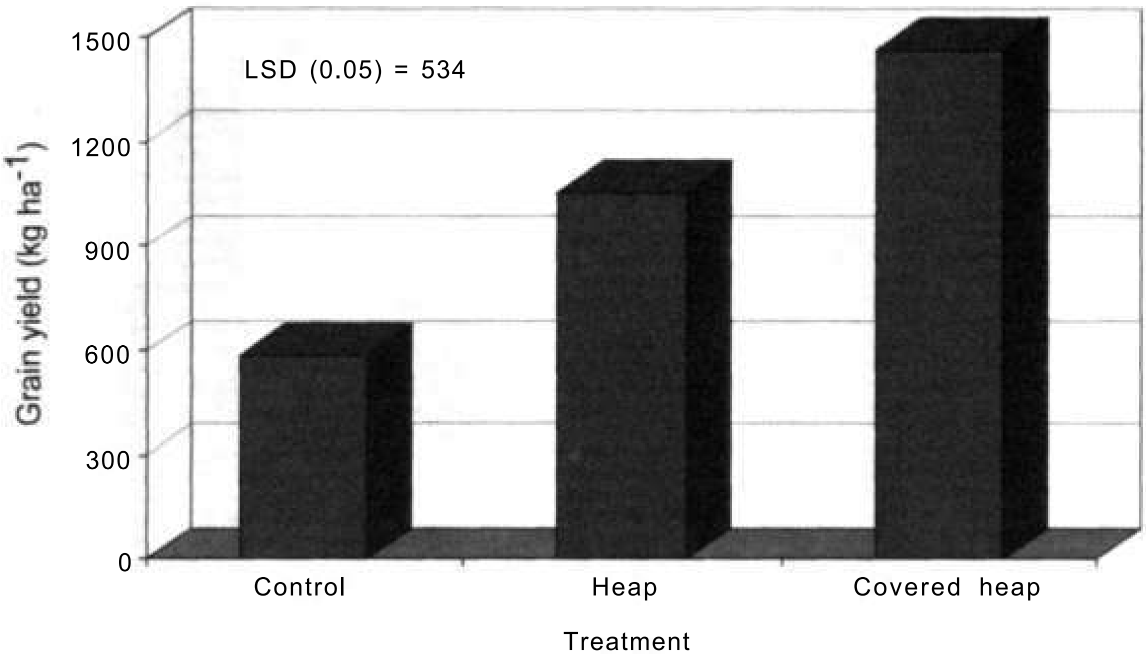

Figure 7. Comparison of heap (uncovered) and covered heap manure treatments on maize crop in Tsholotsho.

Conclusion

The 1999/2000 season was an unusual season with excessive rains at all sites. It was therefore not an ideal one to test the effects of manure storage in Tsholotsho. All the same the results showed it is beneficial to use manure in all soil types albeit at fairly low rates of application. Pit stored manure was found to consistently perform better than the conventional heaping practices. Unfortunately no direct comparisons could be made with treatments where heaps are covered, as the farmers did not have enough manure to set up all treatments at one site. The results on combinations again confirm other findings in the literature on the potential benefits that can be obtained through use of both organics and fertilizers. The way forward, therefore, is to promote this integrated strategy together with use of practices such as pit storage that enhance the value of locally available organic resources. Linkages with extension should be strengthened as a way of promoting the practices tested in this study.

4.2 Best Bets APSIM Modeling Scenario Analysis on Short-term Maize and Nitrogen Fertilizer Recommendations and Long-term Maize/Legume Rotation in Dry Regions of Zimbabwe

Lucia Muza[1]

Crop models help in evaluating production options before they are tested in field trials or even by farmers. Considering the cost of carrying out trials which is sky rocketing each day, crop models will help screen treatments, and reduce expenditure on size of experiments and seasons needed to generate data before recommendations can be drawn. The CIMMYT (Centro Internacional de Mejoramiento de Maiz y Trigo) Risk Project, ICRISAT Soil Fertility Project, and the Maize Agronomy Programme of the Department of Research and Specialist Services (DR&SS) - Zimbabwe have been working on APSIM model validation and calibration. The objective of the project by the Agronomy Programme was to conduct verification trials on:

- Effect of nitrogen (N) application and weeding time on maize grain yield.
- Effect of maize/legume rotation on maize grain yield.

The results from the verification trials will be compared with the APSIM model results.

Site and farmer selection

Initially ward meetings were organized where researchers introduced themselves and their objectives. Farmers highlighted poor soil fertility as one of the major limiting factors to crop production. After a long discussion village heads were chosen by the farmers to host the trials and introduce the researchers and objectives such that every villager will have access to the trials. The researchers implemented and managed the trials.

Materials and methods

The trials were carried out in Zimuto-Mahoto in Masvingo and Tsholotsho District in Matabeleland North, both in natural region 4 in Zimbabwe. The trial had a main

1. DR&SS, P 0 Box CY 550, Causeway, Harare, Zimbabwe.

trial termed the mother trial and five single replications on different households termed baby trials. The mother trial was a split plot design with 3 replications. There were two treatments with weeding time being the main plot factor and N application being the sub-plot factor. Plot sizes for the main trial for N and weeding time experiment were 5.4 m x 6 m and baby plots were 10 m x 20 m. The maize/ legume trial plots were 5.4 m x 12 m. Five baby trials per site were planted for both N and weeding time trial and maize/legume trial.

The main trial included the following treatments:

1. Weeding time:
   (a) weeding at 4 weeks after crop emergence
   (b) weeding at 2 and 6 weeks after crop emergence
2. N rate:
   (a) 0
   (b) 1 bag ammonium nitrate (AN) (17.25 kg N ha^{-1})
   (c) 2 bags AN (34.5 kg N ha^{-1})
   (d) 3 bags AN (51.75 kg N ha^{-1})

The baby trial included the following treatments of weeding time and N rate:

(a) Weeding at 4 weeks after crop emergence without AN
(b) Weeding at 4 weeks after crop emergence with 1 bag of AN (17.25 kg N ha^{-1})
(c) Weeding at 4 weeks after crop emergence with 2 bags of AN (34.5 kg N ha^{-1})
(d) Weeding at 2 and 6 weeks after crop emergence with 1 bag of AN (17.25 kg Nha^{-1})

No basal fertilizer application was done. Top dressing was split applied at 4 weeks after planting and at tasseling. Weeding was done according to the treatment requirement. Stalk borer was controlled using thiodin at 3 weeks after crop emergence. Just before planting and after harvesting soil samples for moisture and nutrients were taken up to one meter depth at 10 cm intervals for Zimuto site only.

Results and discussion

Zimuto trial was affected by cyclone Eline during its growing season. Out of the five baby trials planted only one was harvested. The rest were waterlogged such that we did not manage to harvest even the biomass. The two main trials were not affected by the cyclone because they were on higher ground. The trial on the effect of N application and weeding time on maize grain yield is discussed in detail. The other trial on the effect of maize/legume rotation on maize grain yield is in the first phase. During this season legumes were planted and next season maize will be planted to see the effect of legumes. Means of the incorporated biomass of the legumes are presented.

Significant differences in the N and weeding treatments were obtained at Zimuto-Mahoto only. At this site, increasing N levels from 1 bag AN ha^{-1} (17.25 kg N ha^{-1}) to 2 bags AN ha^{-1} (34.5 kg N ha^{-1}) significantly increased maize grain yield from 552 kg ha^{-1} to 1121 kg ha^{-1} (Table 1). Further increases in N application to 3 bags AN ha^{-1} (51.75 kg N ha^{-1}) reduced grain yield to 711 kg ha^{-1}. Weeding twice at 2 and 6 weeks after crop emergence significantly increased grain yield to 1077 kg ha^{-1} from 314 kg ha^{-1} obtained with weeding at 4 weeks after crop emergence (Table 2). No interaction effect was obtained between the main effects. Only one baby trial was harvested since flooding destroyed the other four. In this trial weeding at 2 and 6 weeks with N application of 17.25 kg ha^{-1} had the highest yield of 1060 kg ha^{-1}. The lowest yield (137 kg ha^{-1}) was obtained when weeding was done at 4 weeks after crop emergence with no N application; grain yields of 607 kg ha^{-1} and 892 kg ha^{-1} respectively were obtained with 17.25 kg N ha^{-1} and 34.5 kg N ha^{-1}.

Table 1. Effect of nitrogen (N) application on maize grain yield (kg ha^{-1}) at Zimuto-Mahoto and Tsholotsho in 1999/2000 season[1].

AN applied (bags ha^{-1})	N content (kg ha^{-1})	Zimuto-Mahoto	Tsholotsho (main trial)	Tsholotsho (baby trial)
0	0.0	397	2332.37	2237.99
1	17.25	552	1897.08	2367.65
2	34.5	1121	2304.60	2256.28
3	51.75	711	1881.81	2577.86
Mean		696	2104.07	2359.95
F-test (5%)		***	NS	NS
LSD		363		

1. AN = ammonium nitrate.
***$P \leq 0.001$; NS = Not significant.

Table 2. Effect of weeding time on maize grain yield (kg ha^{-1}) at Zimuto-Mahoto and Tshlotsho in 1999/2000 season[1].

Weeding time	Zimuto-Mahoto	Tsholotsho
4 weeks after crop emergence	314	2051.79
2 and 6 weeks after crop emergence	1077	2156.14
Mean	696	2103.97
F-test	***	NS
LSD	257	

1. ***$P \leq 0.001$; NS = Not significant.

At Tsholotsho, N application rate and weeding time did not result in significant increase in maize grain yield (Tables 1 and 2). Also, there was no interactive effect ofN application rate and weeding time on maize grain yield. However, yields were higher at Tsholostho compared to Zimuto-Mahoto.

4.3 Zimuto (Zimbabwe): Modeling Linkages

John Dimes[1]

Background

Prior to 1999, the CARMASAT (Collaborations on Agricultural Resource Modeling Applications in Semi-Arid Tropics) project provided technical and training support to the DFID project in Zimbabwe and Malawi for application of the cropping systems model, APSIM. Following relocation from India to Zimbabwe in August 1999, CARMASAT established collaborative links with the Department of Research and Specialist Services (DR&SS) (Zimbabwe) and Department of Agricultural Reseach and Technical Services (DARTS) (Malawi) components of the DFID project's on-farm experimentation. In Zimbabwe, the on-farm trials were located at Mahoto village in Masvingo Province; in Malawi, trials were located at Mangochi, on the southern lakeshore of Lake Malawi.

Objectives

CARMASAT's specific objectives in these collaborations were to:

- Enhance NARS (national agricultural research systems) participatory on-farm experimentation with additional climate, soil, and plant monitoring.
- Evaluate APSIM's capabilities for simulating farmer-managed on-farm trials.
- Explore how simulation contributes to farmer and researcher learning about fertility management technologies in small-holder farming systems in the semi-arid tropics (SAT).

Results

An annual modeling workshop was conducted in September 1999 where APSIM was used to examine issues of household resource allocation in maize cropping systems [e.g., labor for weeding vs nitrogen (N) fertilizer investments]. Based on simulation output, proposed mother/baby trial treatments for DR&SS and DARTS collaborators were adjusted to include extra weeding as a treatment, along with the planned treatments to evaluate low rates of N fertilizer. Hence, simulation made an important contribution to researcher learning through more appropriate trial design, and CARMASAT included weed biomass sampling in its monitoring program to further test simulation of weed competition for water and N.

1. ICRISAT-Bulawayo, P O Box 776, Bulawayo, Zimbabwe.

Workshops in 1998 and 1999 had established the reliability of APSIM amongst project scientists for simulating maize yields and response to N inputs for researcher-managed trials. However, there was little effective data available for testing the model for farmer-managed trials where farm labor constraints meant less than ideal timing for planting, weeding, and fertilizer operations. CARMASAT negotiated with farmers and NARS scientists to have half of the non-replicated baby trials in a village managed by farmers, with seed and fertilizer supplied to farmers by the project, and CARMASAT to monitor soil water, N, and maize and weed growth with sequential samplings. CARMASAT also invested in automatic climate monitoring equipment and provided rain gauges to farmers to record rainfall at the trial sites.

The DFID project has targeted a broader range and more flexible fertility management options by national agricultural research and extension systems (NARES) agencies in Zimbabwe and Malawi as a pathway for encouraging women farmers to invest in soil fertility. In February and March 2000, CARMASAT assisted in conducting workshops with extension agencies and non-governmental organizations (NGOs) in Zimbabwe and Malawi to review existing fertilizer recommendations and to explore opportunities for lowering current fertilizer recommendation using simulation. The workshops provided participants their first exposure to and participation in system analysis using simulation. There was an encouraging response from Agritex scientists in Zimbabwe who indicated a willingness to collaborate on broader testing of lower fertilizer rates with farmers. The response in Malawi was that more model testing was required.

Research outputs 1999/2000

- Detailed climate, soil, and plant yield data for farmer-managed on-farm experiments (data is still being processed, especially for soil analyses).
- Scenario analysis of resource allocation issues in small-holder farming systems in SAT (three workshops: September 1999 - weeding x N fertilizer interactions; February 2000 - manure x N fertilizer combinations; March 2000 - legume rotations).
- Simulation of on-farm experiments (initiated, but awaiting more data processing).
- Meetings and field days with farmers to explain on-farm experiments and share field results.

4.4 Improving Productivity and Incomes for Small-scale Farmers in the Semi-arid Areas of Zimbabwe: On-farm Participatory Research in Gwanda

Geoffrey M Heinrich[1]

Objectives of the project

- Develop practical, sustainable systems for increasing the productivity and incomes of small-scale farmers in Zimbabwe.
- Test a participatory, farmer-led approach for on-farm, farmer participatory research on production systems.
- Link the Sorghum and Millet Improvement Program (SMIP) supported research on production systems with associated SMIP supported research on seed systems and improve farmer's access to improved output markets.

Approach and activities

A series of researcher-managed (RM) trials focused on key technology options that researchers had identified as having particular relevance for the area. These trials included replicated trials on manure and inorganic nitrogen (N) combinations and manure management systems, on a modified tied-ridging system for soil moisture conservation, and on seed priming.

In addition, researchers assisted farmers in testing on-shelf technology to address soil fertility and soil moisture constraints, and other production constraints which farmers had identified as priority issues. The majority of this testing was done through farmer-managed (FM) trials. In this work, SMIP collaborated with the Intermediate Technology Development Group (ITDG), a non-governmental organization (NGO). The ITDG is implementing a complementary project in the area to identify farmer-innovators using improved soil fertility and soil water management systems, and to confirm and disseminate effective technology options already in use among these innovators.

A meeting between research, extension personnel, ITDG, and farmers was held in Manama (Ward 17, Gwanda South district), Zimbabwe in early November 1998. At this meeting, research topics and trial designs were discussed and finalized.

1. ICRISAT-Bulawayo, P O Box 776, Bulawayo, Zimbabwe.

During the season, quantitative and qualitative data were collected on RM trials, while primarily qualitative data was collected on FM trials.

Meetings were held during the year with farmers participating in the trials program. The purpose was to obtain input from farmers regarding their assessments of the technology options being tested. A field day was held just before harvest to raise awareness in the community about promising technology options being tested. At the end of the season, participatory rural appraisal (PRA) techniques were applied with farmers to obtain qualitative farmer assessments of the technology options being tested. A technical report on the research results of the season has been compiled.

In addition to the above research, ITDG led a general PRA at the beginning of the season. This survey indicated that farmers in Ward 17 of Gwanda South district did consider the issue of soil fertility to be one of their major production constraints. During the season, ITDG conducted Training for Transformation for farmers in Ward 17. The purpose of this training was to encourage farmers to take a more pro-active role in the development of their area. ITDG also sought "farmer innovators" in the area (and identified several). Lastly, ITDG led a farmer-to-farmer exchange visit. Farmers from Ward 17 and from Tsholotsho (Ward 13) visited farmers in Chivi, and observed the soil and water management systems being used there. The visiting farmers were so impressed with some of the technologies being applied in Chivi that they immediately implemented some of them upon returning home. Farmers on the visit made reports to their villages after the trip, and also reported their observations at the field day.

Major results, outputs, and implications for other SADC countries

Moisture management x fertility trials

Modified tied ridging

Modified tied ridging (MTR) is a system for conserving rainwater in the field. When the (cereal) crop is about knee-height, the inter-row spaces are plowed once in each direction, creating a furrow. Subsequently the farmer moves down each furrow with a hoe, and blocks the furrow with soil at 1 to 2 m intervals (creating "ties"). Aside from catching rainfall, this operation also controls the majority of weeds. Planting is done across the slope of the field for this treatment to be most effective.

An RM trial that incorporated MTR as a treatment was implemented at three sites this season; two were in Gwanda South District, and the third was in

Tsholotsho district. The trial was in a split plot design, with MTR as a main plot treatment, and four different fertility treatments as sub-plots. Sorghum variety Macia was tested. There were two replications per site. Rainfall this year was much higher than normal due to cyclone Eline.

Analysis of variance of the three trials indicated no significant response from MTR, either within or across trials. This was not surprising, because of the excessive rainfall.

The most important observations relating to MTR this season were:

- MTR was relatively easy for farmers to implement and reduced weeding labor;
- The MTR system did appear to hold water on the field, and to reduce soil loss from erosion; and
- In drier years, MTR is likely to have a significant impact on crop yields due to greater retention of rainfall in the field.

The system will be evaluated in trials again in the 2000/01 season.

Dead-level contours and infiltration pits

As mentioned earlier, ITDG facilitated farmer exchange visits, during which farmers from Gwanda South and Tsholotsho visited farmers in Chivi. The farmers from Gwanda South and Tsholotsho were so impressed with what they saw that some of them immediately applied some of the options in their own fields. The two techniques that impressed the visiting farmers the most were "dead-level contours" and "infiltration pits". Dead-level contours are contour bunds without any gradient. These contours trap and hold surface runoff in the field. To ensure an even retention of water along the length of the contour, these may be blocked with soil at regular intervals. Infiltration pits are pits, roughly a meter deep and about 1 to 2 m long. They are often placed in the dead-level contours. Again, their purpose is to collect runoff, and allow it to percolate into the soil profile, rather than escape from the field. Using these two techniques, farmers in Chivi were apparently able to significantly increase the moisture available for plant growth in their fields in most years.

Given farmers' enthusiasm for these techniques, and the apparent success that farmers in Chivi have achieved (over several years), these techniques should be included in the trials program in the coming season. They should be tested alone, in combination with MTR, and with improved soil fertility treatments superimposed.

Fertility treatments

In the MTR trials described earlier, four separate fertility treatments were compared, with and without MTR. MTR had no effect on yields in this year, but analysis of the results across all three trials showed a significant difference in fertility treatments. The mean grain yield across trials was 1292 kg ha^{-1} in zero farmyard manure (FYM) and zero nitrogen (N) treatment; 1427 kg ha^{-1} in 10 t ha^{-1} FYM and zero N; 1629 kg ha^{-1} in zero FYM and 18 kg N ha^{-1}; and 2182 kg ha^{-1} in 10 t ha^{-1} FYM and 18 kg N ha^{-1}.

Farmyard manure and inorganic nitrogen combinations

The purpose of these trials was to evaluate the potential for using relatively small quantities of FYM and/or minimal amounts of inorganic N to increase crop yields. The levels of N selected for the trials was based on suggested outputs from on-going crop growth simulation work in ICRISAT.

An RM trial was implemented on three farms, two in Tsholotsho (one sand and one clay site) and one in Gwanda South (sandy soil). There were three levels of FYM applied (0, 5, and 10 t ha^{-1}), and three levels of N (0, 9, and 18 kg N ha^{-1}). On each farm, the trials were implemented in a split-plot design, with FYM levels as the main plots. There were two replications per farm. Sorghum variety Macia was tested.

There was no significant effect of FYM on sorghum grain yields, either within or across farms. Nitrogen application significantly increased grain yields at the sandy soil site in Tsholotsho, and when the combined data was analyzed across all trials. The mean yields for the different levels of N across all sites and levels of FYM were 1466 kg ha^{1} with 0 kg N ha^{-1}; 1791 kg ha^{-1} with 9 kg N ha^{-1}; and 2055 kg ha^{-1} with 18 kg N ha^{-1}. Increase in N level did not increase yields significantly.

In addition to the RM trials, 3 farmers in Gwanda South and 20 farmers in Tsholotsho were elected to evaluate FYM and N applications on sorghum in FM trials (these trials had only one replication per farm).

There was mixed success in the implementation of these trials, and some difficulty in analyzing the trial results. The three FM trials in Gwanda were lost to *Striga* and/or bird damage. In Tsholotsho, ten trials were lost because farmers mixed the grain yield from all plots. Of the ten remaining trials in Tsholotsho some farmers used different levels of the treatment variables than were originally planned. Thus the data set useable for data analysis was small. Analysis of the remaining trials showed no significant response to FYM or N application. One possible explanation for this is that most of the trials in Tsholotsho were implemented on heavy clay soils, where the fertility levels were relatively high to start with. Mean grain yields across trials, without either FYM or N were above 2.5 t ha^{-1}.

In end-of-year assessments, farmers in Gwanda South did not evaluate the FYM x N trial. There were few farmers who implemented the trial but there was no yield. In Tsholotsho, farmers concluded that the effects of applications of limited amounts of FYM or N were roughly equivalent, though they were best when combined. They indicated that if a farmer did not have sufficient cash, he/she was better off using FYM.

However, if a farmer had sufficient cash, then application of both, or N alone, were the best and second-best options respectively. Interestingly, this assessment agreed with the results of the RM moisture management x fertility trials described above.

Manure management systems

The purpose of this work was to evaluate the potential for increasing the quality of FYM using different management methods. An RM trial was designed to compare three methods of FYM management (heaped and uncovered, heaped and covered with soil, and buried in a pit). The treatments were applied to two types of FYM (goat and cattle manure). In the "heaped and covered" and "pit" treatments, the treatments were applied in late July/early August of 1999. The soil "cover" on both treatments was removed just before the FYM was applied to the field, in late November/early December 1999. The trial was implemented on 4 farms in randomized complete block (RCB) design, with 2 replications per plot. For all plots that received FYM, an application rate of 5 t ha^{-1} was used. Sorghum variety Macia was tested.

Goat manure gave higher yields than cattle manure within two farms and was significantly better across all farms at the 0.07 level of probability. Across all farms and manure management systems, mean grain yields from cattle and goat manure applications were 887 kg ha^{-1} and 1162 kg ha^{-1} respectively.

Significant differences were observed for manure management systems within two farms, and when the data were analyzed across all farms. Mean grain yields across all farms and manure types were 845 kg ha^{-1} when no FYM was applied; 1338 kg ha^{-1} when FYM was heaped and covered; 1002 kg ha^{-1} when FYM was heaped and uncovered; and 912 kg ha^{-1} in "pit" treatment.

Heaping the manure and covering it with soil was the best system in this experiment. Manure samples were collected before and after the application of each management system for nutrient analysis. The analysis has been delayed but preliminary analysis for nitrate concentration in manure samples collected from 2 farms, agreed with the field trial results. In these samples, nitrate concentrations were lower in cattle manure than in goat manure. Concentrations of nitrate in the heaped and covered treatment increased 10 fold (for both cattle and goat manure), but remained relatively unchanged by the other two treatments.

The lack of response to the "pit" treatment in both grain yield and nitrate concentrations is somewhat surprising since other researchers in Zimbabwe have reported excellent results in improving manure quality with this treatment.

In the end-of-season evaluations, farmers indicated that there was less labor required for the heaped and covered system than for the pit system. The good yield results, combined with the nitrate analysis results and favorable evaluations by farmers, indicate that this technology might be a very useful and practical option for farmers.

Seed priming

Seed priming is the practice of soaking seeds in water just prior to planting. The purpose is to enhance the germination percentage in the field, and speed emergence. In dry areas, stand establishment is often a problem, and seed priming is expected to address that issue.

In the system being evaluated here, farmers would soak the seed for 10-12 hours on the night before planting, and surface-dry the seed in the morning before taking it to the field for planting. With most crops used, if the seed is not planted, it can be dried back to the original moisture level and stored without damage.

An RM seed priming trial was implemented on one farm in Gwanda South and on two farms in Tsholotsho. This trial consisted of comparisons of "primed" and "non-primed" seed of 4 crops: sorghum (Macia), pearl millet (PMV 3), cowpea (NTS 106), and bambara groundnut (landrace). The trials were in an RCB design with 2 replications per farm.

In addition, 8 farmers in Gwanda South and 8 farmers in Tsholotsho implemented FM seed priming trials (1 replication per farm) with one or more of the same crops.

Analysis of results within and across RM trials showed no significant grain yield advantages from seed priming. The same was true for FM trials. This was not surprising, since this was relatively a very wet year, with no moisture deficits during the planting and seedling establishment period.

However, farmers who implemented the trials indicated (both RM and FM trials - end of season assessments) that in virtually all cases, and over all crops, the primed seed emerged 1-3 days earlier than the non-primed seed. They indicated that priming was a very easy and inexpensive technology option, and that they felt it could have significant advantages in drier, more "average" years. This option will be tested again next season.

Legume rotations

The purpose of these trials was to test the potential of several legumes (groundnut, bambara groundnut, and cowpea) to improve the grain yield of sorghum and/or pearl millet when grown in a rotation. These trials were all implemented in an FM format. In this season, farmers planted relatively large areas of the legumes (at least 10 m x 25 m plots) with an adjacent plot of a cereal (primarily sorghum). In the coming season, the soil will be sampled both at the beginning and end of the season, and a cereal crop will be grown on the plot planted to legumes as well as on the plot planted to the cereal. As this was the first year of the rotation trial, there were no yield comparisons obtained, though yields of the legumes were measured.

Seventeen farmers in Gwanda South elected to test legume rotations as an option to improve soil fertility, as opposed to just 8 farmers in Tsholotsho. This was contrary to the test on ammonium nitrate application, where 20 farmers in Tsholotsho elected to test this option, versus only 3 in Gwanda South. Though the difference in preferences between Tsholotsho and Gwanda South were clear, the reasons for the difference were not. These differences in preference may be worth investigating further.

Summary and conclusions

Technology options

The data and results presented above are from one year, and a year in which rainfall was well above the norm, and also well distributed. In addition, the profitability of the options being tested is still being evaluated. Also, the analysis of soil samples collected during the season is not yet complete. Information on the soil and FYM nutrient status and on the profitability of the various technology options in the program will provide important additional information for interpreting the outcome of the trials. The results, above, therefore need to be interpreted with caution, and will need to be confirmed over the next season or two. Preliminary results and conclusions from this season are discussed below.

Soil moisture management options

As this was a "good" rainfall year, it was not surprising that there were no yield gains associated with MTR. However, MTR, dead-level contours, and infiltration pits all appeared to be acceptable and practical for farmers, and to hold promise for years in which soil moisture availability is more limiting. MTR did not reduce yields at all in this season, suggesting that it is not a "risky" technology. Practical systems that increase moisture availability in drier seasons may also help in making investments in soil fertility less risky as well. Testing of these soil moisture management options, alone and in combination with soil fertility management options, will be continued in the coming season.

Soil fertility management options

Trials with inorganic N supported the indications from the crop growth simulation program that significant yield gains could be achieved with relatively small applications of N. Farmers in Tsholotsho, in particular, concluded that investments in small amounts of inorganic N for topdressing would have more positive and immediate pay-offs than the addition of small quantities of FYM. This was also supported by the trial results this year, assuming that farmers were using FYM without any attempt to improve its quality.

The trial on manure management, however, indicated that with proper management (in this case, heaped and covered for a period of approximately 3 months) manure quality could be improved, and provide a yield benefit in the first season of application. How the residual effects of the FYM application would be affected in future years has not yet been determined, but presumably an immediate benefit is none-the-less desirable. Another interesting result was that in Gwanda South, the goat manure appeared to be of higher inherent quality than the cattle manure. A literature review by Giller and Mapfumo in 1999 indicated that there has not been much study on goat manure in Zimbabwe. These results indicate that it is a potentially very valuable resource that should not be overlooked.

Farmer assessments of technology options

In end of season assessments, farmers indicated that most of the technology options being tested appeared to be practical, and farmers indicated their preferences for several of the options. It remains to be seen whether farmers will be willing to invest in inorganic N, but most of the other options in the testing program do not require an actual cash outlay. Farmers' evaluations indicated that there are several promising options that may be very useful in future.

Constraints

To ensure that the trials were well implemented (especially the RM trials), more field visits were required than had been initially planned. In addition, extensive soil sampling was done to facilitate interpretation of trial results, and to allow greater integration with the crop growth simulation activities. The additional sampling is expected to add significant value to the final database, but it was not considered in the initial budget calculations. As a result, the travel costs for implementing this work were considerably higher than planned, and expenses exceeded the budget originally presented to the SMIP Work Plan Assessment Committee. However, the total budget planned for IR 1.2 in 1999/2000 was not exceeded, and the additional travel was essential for implementation of this activity.

Achievements

One of the key milestones for SMIP IR 1.2 is to identify practical and effective soil water and nutrient management technology options that can and will be adopted by farmers. These options are expected to be utilized in the target areas of the program, and lead to the increases in farm productivity that are required in the indicator for IR 1.2.The activities and results described above contributed directly and positively toward the identification of suitable technology options that can contribute to this process.

4.5 Zimuto (Zimbabwe): Farmer Participatory Research Group

Kit Vaughan and Zondai Shamudzarira[1]

Background

- Climatic risk associated with erratic rainfall is the key constraint to adoption of improved soil fertility technologies.
- Low soil fertility is the key constraint to increase in production.

Purpose

Evaluate the climatic risk implications of soil fertility technologies being developed by members of the Rockefeller Soil Fertility Network, through the combined use of crop simulation models and farmer participatory approaches.

Concepts and current soil fertility context

- Concept: Combining participatory approaches with crop modeling to evaluate options.
- Appropriate soil fertility recommendations [e.g., rates of nitrogen (N) and manure application] are lacking.
- Historical influence, e.g., no intercropping.
- Farmers have developed own best practices.
- Gaps in knowledge of best bet "flexible" and appropriate options.
- Thus farmer participatory research (FPR) should be combined with modeling and farmers knowledge with best bet research.

Partners in the work

- CIMMYT
- APSRU
- DR&SS
- Agritex
- University of Zimbabwe
- University of Malawi

1. CIMMYT-Zimbabwe, P 0 Box MP 163, Mount Pleasant, Harare, Zimbabwe.

- Chitedze Research Station
- ICRISAT/CARE International
- Rockefeller Soil Fertility Network
- Silsoe Research Institute

Methods development

- Highly original-linking quantitative and qualitative processes.
- Model calibration and validation on-station and on-farm.
- Selection of representative field sites (Figs. 1 and 2) (Site similarity).
- Selection of representative farmers (Wealth ranking).
- Development of "partner" linkages (NGOs and NARS) and integrated site process.
- Development of FPR model linkages.

Zimuto process and technologies - 7 integrated sites

1. Makoholi/Drewton: on-station replicated farmer trials (Fig. 1).
2. Control: no interventions baseline survey.
3. DR&SS: legumes and maize by N and weeding (mother and baby trials).
4. Maize variety trials (CIMMYT SADLF).
5. N tracking (resource flow maps).
6. Farmer experimenters: design, manage, and monitor trials.
   Options: Legumes; N x lime x variety.
7. UZ SMP best bet efficient N use.

Participatory processes for sites 4, 5, 6, and 7

- Semi-structured interviews.
- Focus group discussions.
- Wealth ranking exercises.
- Cross check key informants' representativeness.
- Transect walks.
- Soil fertility resource allocation maps.
- Ranking exercises for soil fertility constraints and opportunities.
- Farmer-based experimentation and participatory technology development.
- Scored problem causal diagrams.
- Farmer participatory budgeting.

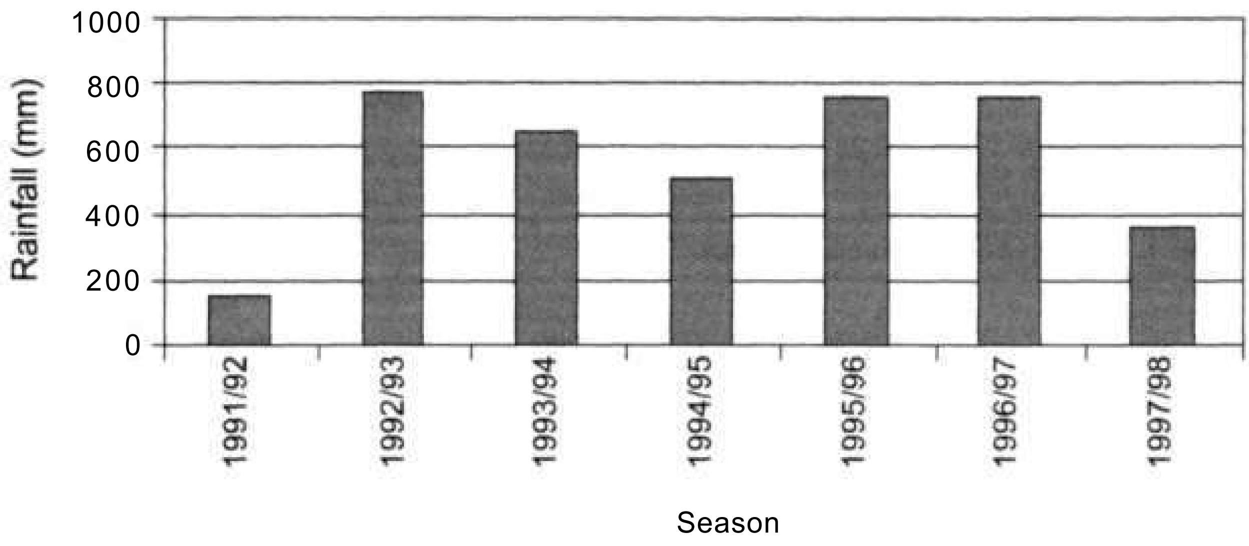

Figure 1. Variations in seasonal rainfall during 1991 to 1998 in Makoholi Experimental Station.

Wealth ranking criteria developed by communities in Zimuto

Eight key factors were identified (Fig. 3):

- Livestock ownership (see Table 1)
- Arable fields: size and type
- Access to farm implements
- Access to cash
- Farming knowledge
- Seed availability
- Farmer age
- Labor availability

Wealth ranking categories developed by communities in Zimuto

- Category 1
  - Have both implements and sufficient fertilizer (DAP - diammonium phosphate).
  - Own fields in the vleis.
  - Own herd of cattle (4 and above).
- Category 2
  - Generally have 4 cattle but lack a few items, e.g., rake/plow or 1 or 2 oxen.

- Category 3
  - Own either some implements but no oxen or no implements.
- Category 4
  - No cattle, oxen, and implements.

Table 1. Field types and farmer types.

Farmer type	Vleis (bottom lands)	Homestead gardens	Toplands
A			
Abundant livestock. Full plowing team.	Key field area. Items linked to timeliness of sowing. Will receive soil fertility input priority.	Inorganic fertilizer used, if at all, in areas not recently receiving manure, compost, leaf litter. or household waste for small plants to establish. Abundant manure means that inorganic fertilizer less likely to be used on home gardens.	Manure more likely to be applied from time to time to some toplands. Inorganic fertilizer more likely to pay off and therefore more likely to be used, because biophysical response is greater within one or two years of manure applications. Items linked to timeliness of sowing.
C			
Few or no livestock. No team hand operations.	Unlikely to have access. Items linked to late sowing.	Inorganic fertilizer used, if at all, in areas not recently receiving manure, compost, leaf litter, or household waste for small plants to establish. Little manure available means that inorganic fertilizer is more likely to be used on home gardens. Items linked to late sowing.	Manure less likely to be applied to toplands. Inorganic fertilizer less likely to pay off and therefore less likely to be used, because biophysical response is small if no manure is used in the previous one or two years. Items linked to late sowing.

Project achievements

- Trained staff and cooperators in APSIM.
- Generating N management scenarios - linking the model and farmers.
- Training in and use of FPR methods - whole farm resource mapping.
- Farmer experimentation, modification, and feedback of several technologies, including annual legumes (Table 2).
- Farmer developed strategies for soil fertility management (Fig. 2).

Way forward for 2000/01

Possible farmer and researcher identified soil fertility options: Fertilizer

- Farmers best practice versus Agritex and SMP.
- Tracking scarce N in whole farm system.
- Split applications/timing and rates.
- Organic/inorganic mixes.
- Investment in fertilizers: ammonium nitrate versus compound D.

Possible farmer and researcher identified soil fertility options: Legumes

- Tried by different field and farmer types. Sole crop green manures: incorporation versus removal versus grazed.
- Cowpea and maize intercrop
- Cowpea and maize relay crop
- Cowpea sole crop
- *Mucuna* and maize intercrop
- *Mucuna* and maize relay crop
- *Mucuna* sole crop
- *Casuarina cunninghamiana* and *Crotalaria juncea* sole crop

Methods development

- Participatory budgeting of soil fertility tradeoffs
- Confirmation of farmer resource groups and field types
- Resource allocation map training and development
- Budgets developed from maps
- Soil fertility research priority needs assessment
- Scenario interpretation
- Model calibration of manure and legumes

Table 2. Typical crop management practices on different field types in Zimuto.

Males	Females
Vlei	**Vlei**
• Planting in early Aug/Sep	• Planting in early Sep
• 2 weedings (Sep/Dec)	• 2 weedings (Sep/Dec)
• No fertilizer; no manure	• No fertilizer; no manure
Homestead	**Homestead**
• Manure application (5 t ha^{-1})	• Manure application (5 t ha"[1])
• Planting in Dec	• Planting in Oct/Nov
• Weeding (Dec end)	• Weeding (Dec end)
• Ammonium nitrate application	• Ammonium nitrate application
Topland 1	**Topland 1**
• Planting in Jan	• Planting in Jan
• No weeding	• No weeding
Topland 2	**Topland 2**
• Planting groundnut in Dec	• Planting groundnut in Nov
• No weeding	• One weeding

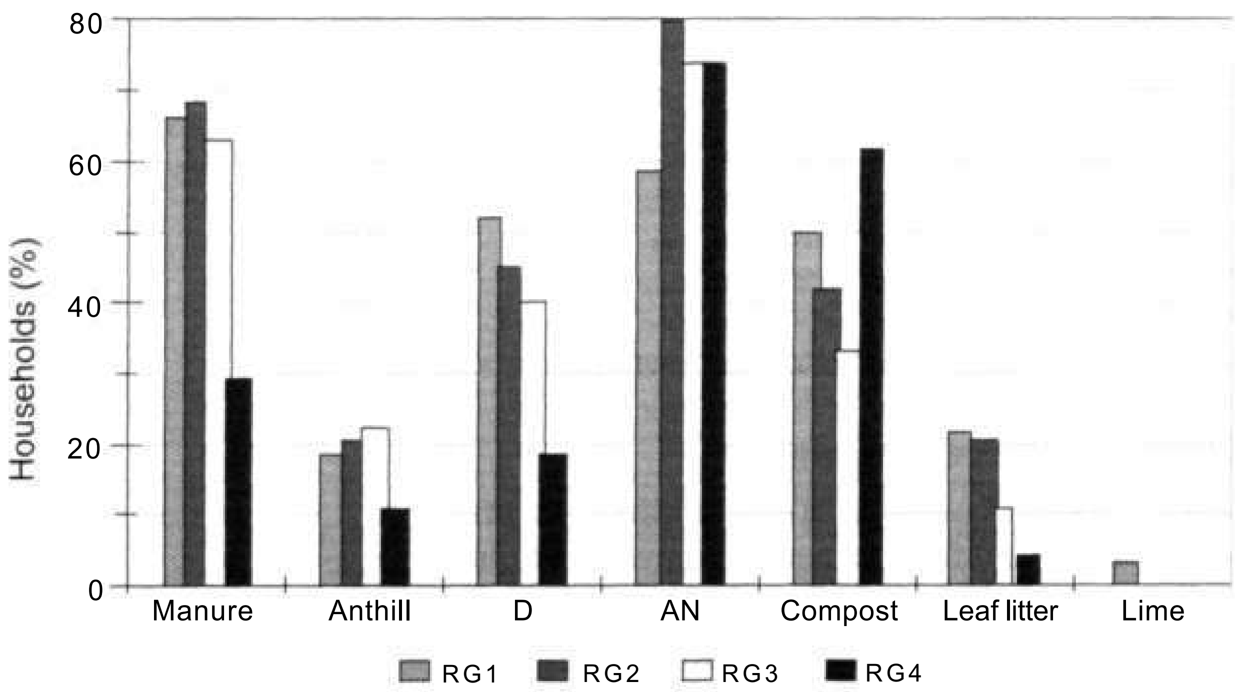

Figure 2. Soil fertility management practices carried out by different resource groups (RGs) in Zimuto.

Upcoming activities

- Farmer and researcher planning workshop at Alvord
- Annual Risk Management Project (RMP) workshop with main objectives as follows:
  - Review past season RMP and partner activities
  - Field test linkage methodology
  - Prepare for review
  - Field plan current season
  - Plan RMP phase 2: Focus on extension, Zimuto, scaling up, technology adaptation and verification
  - RMP external review
  - Implement focused field activities

4.6 General Discussion on Zimbabwe Presentations

Lawrence Gono[1] (*facilitator*)[1]

The facilitator started the discussion by explaining that soil fertility management is a priority issue in agricultural research. He also said that technologies that work have been developed but these technologies have not been adopted.

Issues arising from the presentations

- Manure increased maize yields to 3-9 t ha^{-1}. Low rates of manure can be used.
- There is a positive response in yield from nitrogen (N)/manure combinations.
- Pit storage of manure gave better yield responses in Shurugwi and Gwanda in Zimbabwe, but the issue of the labor required to manage the pits was raised. What implications do financial constraints have?
- Nitrogen by weeding results support the fact that N gives good yield responses though there was no response in one area.
- There are several questions related to farmer participatory research modeling. The project is 1.5 years long. How much can we achieve in such a short time? Are we capable in terms of time and costs that are involved in modeling?

Discussion

One participant opened the discussion by an observation that when resources and resource categorization are considered in terms of opportunity costs whatever is worth pursuing is a function of its resources. If the focus continues to be on resources, how far could research go? There are issues of livestock versus cropping. There is also a moral hazard problem when wealth ranking is carried out with farmers. For farmers wealth ranking becomes an analytical platform. It was however argued that wealth ranking is a cost effective analytical tool in characterizing what options one could suggest to the farmers. There is a need to think about the decisions that households are making and there is also a need to analyze them.

A lot of investment was put into discussions with farmers in the Risk Management Project in Zimuto, Zimbabwe raising questions on whether it was really worth it. It was explained that originally there were no clear steps and it was worth the effort to get things right as in modeling it is assumed that there will be

1. Sorghum/Millets Program, Matopos Research Station, P B K5137, Bulawayo, Zimbabwe.

huge pay-offs in the end. The time spent in investment gives the farmers incentives to continue experimenting; an example cited was that of Sanyati farmers who have continued to work on their farms since 1996, following the end of the DFID-funded project (R4840) between Cotton Research Institute (CRI) and Silsoe Research Institute (SRI).

Zimbabwean NARSs (national agricultural research systems) researchers raised concern about the timeframe of the project. What would happen at the end of the project? It was explained that this project will be linked and therefore it was likely to continue.

The issue of partnerships also came up. It was agreed that generally if good partnerships are identified research becomes more effective in terms of the investments. Partnerships are important in the identification of issues.

It is important to meet farmers' expectations so that trustful relations can be built with the communities. Levels of understanding differ; hence investment in common understanding is essential.

5. Presentations on Participatory Research Methods

5.1 Comparative Review of Participatory Research Methods

Ade Freeman[1]

The purpose of comparison of participatory research methods was to:
- Check researcher characterization of research method.
- Identify main differences in methodology that project team could compare.

Expected output

- Guidelines or lessons for participatory research particularly as it relates to developing technologies relevant to women.
- Strategies for selecting trial farmers:
  - Village headmen
  - Volunteers
  - Farmers select within their community
  - Extension staff or enumerators
  - One case: baseline survey data used to select women farmers for experimentation.

Methodology

Following a series of visits to each collaborator's field site the matrix presented in Table 1 was used to characterize the different types of experimentation that were being undertaken, and the degree of researcher and farmer involvement in the research process.

1. ICRISAT-Nairobi, P 0 Box 39063, Nairobi, Kenya.

Table 1. Proforma for characterization of trial type.

Research process	Researcher only (no farmer involvement)	Researcher with passive farmer involvement	Researcher and farmer jointly (negotiated process)	Farmer with researcher involvement	Farmer without researcher involvement
Diagnose problem					
Identify opportunities					
Set priorities					
Identify option					
Planning experiments - How - Where - Who - With what					
Conducting experimentation					
Assessing results					
Training Plot layout Replication Monitoring trials/data collection					

Categorization of the different on-farm approaches

The different trials undertaken were characterized and researcher and farmer involvement is shown in Tables 2-7.

Table 2. Traditional on-farm research.

Research process	Researcher only (no farmer involvement)	Researcher with passive farmer involvement	Researcher and farmer jointly (negotiated process)	Farmer with researcher involvement	Farmer without researcher involvement
Diagnose problem	√				
Identify opportunities		√			
Set priorities		√			
Identify options		√			
Planning experiments					
-How	√				
-Where		√			
-Who		√			
- With what	√				
Conducting experimentation	√				
Assessing results		√			
Training Plot layout Replication Monitoring trials/data collection	√				

Table 3. Mother/Baby trial design.

Research process	Researcher only (no farmer involvement)	Researcher with passive farmer involvement	Researcher and farmer jointly (negotiated process)	Farmer with researcher involvement	Farmer without researcher involvement
Diagnose problem	√				
Identify opportunities		√			
Set priorities		√			
Identify options		√			
Planning experiments					
-How		√		√	
-Where		√		√	
-Who		√		√	
- With what	√	√			
Conducting experimentation	√			√	
Assessing results	√	√		√	
Training Plot layout Replication Monitoring trials/data collection	√	√			

Table 4. Farmer-led research - Farmer experimentation linked to mother/baby trials.

Research process	Researcher only (no farmer involvement)	Researcher with passive farmer involvement	Researcher and farmer jointiy (negotiated process)	Farmer with researcher involvement	Farmer without researcher involvement
Diagnose problem	√				
Identify opportunities		√			
Set priorities		√			
Identify options				√	
Planning experiments					
-How				√	
-Where				√	
-Who				√	
- With what			√		
Conducting experimentation				√	√
Assessing results				√	√
Training Plot layout Replication Monitoring trials/data collection					

Table 5. Integrated management by researchers and farmers.

Research process	Researcher only (no farmer involvement)	Researcher with passive farmer involvement	Researcher and farmer jointly (negotiated process)	Farmer with researcher involvement	Farmer without researcher involvement
Diagnose problem			√		
Identify opportunities			√		
Set priorities			√		
Identify options			√		
Planning experiments					
-How	√			√	
-Where		√			√
-Who				√	
- With what		√		√	
Conducting experimentation		√		√	
Assessing results			√	√	
Training Plot layout Replication Monitoring trials/data collection		√		√	

Table 6. Farmer-led research - Researchers facilitate farmer experimentation.

Research process	Researcher only (no farmer involvement)	Researcher with passive farmer involvement	Researcher and farmer jointly (negotiated process)	Farmer with researcher involvement	Farmer without researcher involvement
Diagnose problem			√		
Identify opportunities			√		
Set priorities			√		
Identify options			√		
Planning experiments					
-How			√		
-Where				√	
-Who				√	
- With what				√	
Conducting experimentation				√	
Assessing results			√	√	
Training					
Plot layout			√		
Replication		√	√		
Monitoring trials/data collection				√	

Table 7. Farmer-led research - Farmer empowerment.

Research process	Researcher only (no farmer involvement)	Researcher with passive farmer involvement	Researcher and former jointly (negotiated process)	Farmer with researcher involvement	Farmer without researcher involvement
Diagnose problem				√	
Identify opportunities				√	
Set priorities				√	
Identify options		√			
Planning experiments					
-How			√		
-Where				√	
-Who				√	
-With what				√	
Conducting experimentation				√	
Assessing results		√	?	?	
Training Plot layout Replication Monitoring trials/data collection			???		

Key issues

- Are the different research teams specifically targeting women farmers?
- Objectives of different types of trials.
- Farmer training and experimentation.
- Farmer experimentation and feedback.
- Evaluation criteria/impact indicators (process outcomes vs final impacts).

5.2 Impact Indicators for Comparing Participatory Research Approaches to Promote Soil Fertility in Semi-arid Southern Africa

Joseph Rusike[1]

Background and problem statement

Farm surveys conducted in semi-arid areas in southern Africa consistently show that smallholders fail to get yields obtained by researchers in trials conducted on research stations and farmers' fields. The yield gap continues to persist despite widespread adoption of improved open-pollinated varieties and hybrids. Much of the yield gap is explained by non-adoption of complementary agronomic management practices needed for farmers to fully exploit the yield advantage in new cultivars bred by breeders (Blackie 1994, 1995). Most crop management recommendations currently diffused to smallholders through extension are not useful to farmers because they are made without considering their severe resource constraints, high riskiness, uncertainty of crop and animal production, and risk-aversion. Most technologies officially recommended to smallholders by government extension services are a deduction or interpolation of recommendations for large-scale commercial farmers. Rapidly increasing population in many African countries is increasing population pressure on land. Because the land frontier has been closed, farmers need to find ways to intensify crop production; increase yields per unit area; and improve household food security, incomes, and employment. Soil infertility, low and erratic rainfall, and drought have over the years been identified as binding constraints on agricultural productivity growth throughout the semi-arid tropics (SAT) in sub-Saharan Africa. A major challenge facing sub-Saharan Africa is to find an agronomic-led technology path for farmers in marginal areas, which expands investments in soil fertility improvement in order to remove the binding constraints of poor soils, unreliable rainfall, and drought.

1. ICRISAT-Bulawayo, P O Box 776. Bulawayo, Zimbabwe.

Recently, researchers have increased interest in the development and diffusion of integrated soil, water, and natural resource management technologies that improve soil fertility, reduce risks and raise farm incomes across-the-board throughout semi-arid smallholder areas. Because farmers in SAT have learned to subsist in complex environments over time, a number of projects have begun to look at how researchers can engage farmers in the research, development, and diffusion of appropriate soil fertility management technologies. This has led to a proliferation of tools that have culminated in "farmer participatory research" (FPR).

This paper summarizes from literature what researchers and farmers currently know about FPR approaches and then develops a conceptual framework and indicators to evaluate the impact of alternative participatory research methodologies. The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) has implemented FPR trials in Malawi and Zimbabwe starting in 1997/98 to test a range of researcher-derived best bet soil fertility management technologies and evaluate the impact of alternative FPR approaches. The research is being conducted in collaboration with the National Agricultural Research and Extension System (NARES), non-governmental organizations (NGOs), the Centro Internacional de Mejoramiento de Maiz y Trigo (CIMMYT), and the Tropical Soils Biology and Fertility (TSBF). The FPR approach is being used to generate data on technical performance of the technologies and to get a platform for discussion with farmers and elicit feedback. It is also used to obtain data for validating crop simulation models and to develop scenarios for modeling and taking back to farmers and extension agents for discussion and scaling up.

The general objective of the project is to develop practical soil fertility management recommendations and participatory research methodologies linking FPR with crop systems simulation modeling through case studies targeted at improving the welfare of women farmers. The specific objectives of this paper are to:

- Review the literature on FPR approaches and how these relate to the range of practices being pursued in Malawi and Zimbabwe.
- Develop a conceptual framework for analyzing the impact of alternative FPR approaches for developing and dissemination of soil fertility management options.
- Develop indicators for assessing the performance of alternative FPR methodologies within the context of the project.

Literature review

Research on farmer participatory technology development and gender analysis in the process of technology development and diffusion in developing countries is becoming popular among NGOs, national agricultural research systems (NARSs), international agricultural research centers (IARCs), and development agencies.[2] This is because there is increasing dissatisfaction with the traditional 'transfer of technology" approach to agricultural research and extension in generating practical technologies that meet the diverse production needs of smallholders. The shift to FPR is being pursued in part because of the realization that farmers are researchers in their own right with indigenous knowledge of local conditions and in part because of increasing feminization of agriculture, which requires expanding participation of women in development of technologies suitable for their specific needs in order to have an impact.

Selener (1997) argues that during the 1950s and 1960s agricultural technology generation and dissemination was dominated by the transfer-of-technology approach.[3] This approach conceptualizes technological change and productivity growth as the end results of a one-way flow from fundamental science to adoption by farmers and improvements in productivity and welfare. Fundamental science yields discoveries, which lead to experimental findings by applied scientists in research centers and experiment stations, which lead to acts of invention, which lead to innovations that are passed on to extension services for dissemination to farmers, which engender imitation and adoption, and which then yield changes in productivity and improvements in welfare. However, the transfer-of-technology approach resulted in the generation of inappropriate technologies that farmers failed to adopt. Poor adoption of agricultural technologies led researchers to implement the Training and Visit System of agricultural extension in order to improve extension, which they perceived to be the bottleneck. However, the problem of non-adoption of technologies continued. In the late 1970s researchers developed farming systems research (FSR) approaches to focus research at the farm level in order to remove constraints on adoption of new technologies. In the 1990s some researchers began to question the appropriateness of technologies that farmers were being encouraged to adopt and this gave rise to FPR as an approach for the development and adoption of improved agricultural technologies to create sustainable agricultural production that will benefit resource-poor farmers.

Selener (1997) argues that FPR consists of seven elements. The first element is that the main objective is to include resource-poor smallholder farmers in making decisions about the generation of agricultural technologies that solve their

2. A classic study by Fujisaka (1994) analyzes the evolution of participatory research in IARCs, focusing on trends in the International Rice Research Institute (IRRI), and concludes with a pessimistic view of the future of participatory research within the CG system outside Africa. Becker (2000) argues that there has been renewed interest in participatory research within the CG in recent years and that this is driven by the lack of impact in eliminating rural poverty and demand by donors for fanner integration into research in order to produce more relevant results.

3. Selener (1997) provides a critical and detailed review of literature on participatory research in community development, action research in organizations, action research in schools, and FPR. This section draws from his review of the origins, definition, focus, and characteristics of FPR. The main authors in the FPR field include S Biggs, Robert Chambers, John Partington, Jacqueline Ashby, R Rhoades, Roland Bunch, Clive Lightfoot, Janice Jiggins, and B P Ghildyal.

production problems. Second, farmers actively participate in the identification of problems, needs, opportunities, and priorities, in design and implementation of experiments, and in the evaluation of results. Third, research is conducted in farmers' fields. Fourth, scientists learn and work with farmers, facilitating and providing support. Fifth, FPR is based on a systems perspective that requires an understanding of the entire system and solving an agricultural technology problem in order to benefit the farm as a whole. Sixth, FPR involves interdisciplinary collaboration and dialogue between farmers and agricultural and social scientists. Finally, FPR is broad, flexible, and adaptive to changes in hypotheses, needs, and local conditions over time.

The underlying assumptions of FPR are that farmers possess indigenous knowledge of their farming systems and environments and that farmers have a capacity for experimentation. These capabilities need to be used and strengthened for technology development.

Biggs (1989) developed a typology of farmer participatory approaches based on objectives of the research and organizational and managerial arrangements put in place for implementation. He defines four types of FPR approaches:

- Contractual: Farmers have a minimal role, mostly providing land and services for scientists to use for carrying out experiments according to researchers' design primarily aimed to produce trials and written reports.
- Consultative: Researchers consult farmers, diagnose their problems and develop solutions through informal and formal surveys, trials, reports, and field days for extension.
- Collaborative: Joint participation at different stages throughout the research process through village research legitimacy meetings, meetings for diagnosis, planning, and interpretation, trials, and formal surveys.
- Collegial: Scientists work together with farmers to strengthen farmers' capabilities at the individual, village, and community levels to carry out research and request information and services from formal systems.

Selener (1997) classifies research conducted on farms based on the level of control and management exercised by farmers into four main types: researcher-managed on-farm trials; consultative researcher-managed on-farm trials; collaborative farmer-researcher participatory research; and farmer-managed participatory research.

Selener argues that researcher-managed and consultative researcher-managed on-farm trials are not FPR. This is because farmers either have no or limited participation in the identification of the research agenda, design and implementation of trials, validation, and evaluation of the technology. Under the collaborative farmer-researcher participatory research type, farmers and researchers balance their participation and control during problem definition, design, management and implementation of trials and evaluation. Under the farmer-managed participatory research category, farmers are major decision makers in identifying problems and needs to be addressed, planning and designing experiments, and testing and evaluating technology options. Some scientists argue that the four types of participatory research defined by Selener are too restrictive and unrealistic because they exclude many kinds of dialogue among farmers and researchers such as participatory on-station breeding.[4]

Lilja and Ashby (2000) define five different types of participatory research based on who makes the decision in the innovation process, and whether or not the decision is made with organized communication. These include: Type A (on-farm research) in which scientists make the decision alone without organized communication with farmers; Type B (consultative) in which scientists make the decision alone but with organized communication with farmers; Type C (collaborative) in which scientists and farmers jointly make decisions through organized two-way communication and no party has a right to revoke the shared decision; Type D (collegial) in which farmers make decisions based on organized communication with scientists and farmers have a right to revoke decisions; and Type E (farmer-experimentation) in which farmers make decisions individually or collectively without organized communication with scientists.[5] On-farm research and consultative types of research with limited farmer participation are not empowering. In contrast, collaborative, collegial and farmer-experimentation are empowering for social change (Ashby 1997).

The epistemological assumption of FPR is that it synthesizes farmers' indigenous knowledge and experience and researchers' science-based knowledge in complementary ways. There is no single way to implement FPR. But the major objective of FPR is for farmers and scientists to work collaboratively and solve agricultural production problems. Therefore, FPR processes follow common methodological guidelines. The stylized stages of FPR include problem analysis and needs identification; searching for solutions and selecting those to experiment; on-farm experimentation; and evaluation of technology.

Five outcomes of FPR are the generation and adoption of new appropriate technologies by small-scale, resource-poor farmers to help solve production problems and increase farm productivity and income; better understanding by researchers of systems used by resource-poor farmers and their decision-making criteria; better understanding by researchers of biophysical and socioeconomic constraints and potential agricultural problems requiring basic research in

4. For example, phase one of the participatory bean selection program in Rwanda analyzed by Sperling and Scheidegger (1995) took place cm-station before normal on-farm testing.
5. These types of participatory research correlate with commonly used typology in the literature; for example, Biggs (1989).

experiment stations; improved research and extension system; empowerment of farmers for self-directed technology development and ability to adapt farming systems to changing conditions; and increased democratization and development of cost-effective research and extension methodologies.

Researchers have tested and found evidence in support of the hypothesis that increasing farmers' participation in the diagnosis of problems and in subsequent research design would result in different conclusions and recommendations (Ashby 1987). It has been concluded that research that does not involve farmers as active members in the early phases runs the risk of developing technologies of little relevance and of low adoption. Farmers who experiment alone obtain lower yields and reach different conclusions regarding use of inputs than those working with researchers. Early participation of farmers has been found to lead to selection of potentially useful options that are rejected by researchers working alone.

The FPR approaches being tried in the ICRISAT program and by different researchers and farmers vary in between the extreme ends of the continuum of researcher-managed on-farm trials and farmer-managed participatory research. The methods being tested are researcher-led, traditional; researcher-led, farmer input; farmer-led, researcher input; and control without any intervention. The researcher-led, traditional approach matches Lilja and Ashby's Type A (on-farm research) category. The researcher-led, farmer-managed approach coincides with Type B (consultative) and Type C (collaborative) types. The farmer-led, farmer-managed approach matches Type D (collegial) and Type E (farmer experimentation).

Fieldwork is being conducted in case study areas of Malawi and Zimbabwe. The six case study areas are Tsholotsho, Gwanda, and Zimuto in Zimbabwe; and Chisepo, Dedza, and Mangochi in Malawi. Different leadership, institutional responsibilities, and experimentation plans were defined at the start of the research for different sites. Implementation has differed in various sites because of the need to adapt to different circumstances and learning over time by farmers and researchers.

How can we learn from these institutional experiments? This paper develops a framework for drawing lessons from experiments that are occurring and for extending their implications into new areas. For example, if an FPR approach is tried for one research problem, it is useful if we could infer how it might work if it is applied to a different problem or area.

Conceptual framework and research hypotheses

A conceptual framework is needed to help us organize the experience of alternative FPR experiments, draw hypotheses for the impact and cost-effectiveness of different FPR methods for social change activities that will improve soil productivity and benefit marginal smallholder farmers, and guide data collection and analysis. The ultimate goal is to work with farmers and key government and private sector decision makers and generate technological, organizational, and institutional innovations with a potential to improve smallholders' soil fertility management while introducing scientists' best bet technologies and building institutions and policies to increase options for expanded access to resources, markets, and infrastructure.

To analyze the consequences of alternative FPR methods for social change, one can draw on the pioneering contributions of Schmid and others of the new institutional economics.[6] Schmid (1987) theorizes that each commodity has a set of inherent characteristics, which are determined by its physics and biology and this comprises the situation. The situation interacts with the type of institutional structure chosen to control and direct its production and use and this determines the resulting performance in terms of who gets what and whose preferences get counted.[7] If we can understand how the different attributes of a commodity interact with different kinds of institutional structures then we can predict the consequences of alternative structures. For example, if we identify under an experiment that a particular FPR approach is instrumental in achieving a particular performance for a given kind of situation then we may predict that this approach will give the same performance when the same type of approach is used for a different problem that represents the same kind of situation. Alternatively we can predict how performance will differ when an approach used in one situation is applied a different problem representing a different situation.

Agricultural technology and knowledge about technology may be viewed as a resource commodity. But knowledge is not a commonplace commodity (David 1992,1993, Arrow 2000). It is highly differentiated and specific in nature. It has no natural units of measurement. Agricultural technological knowledge is also characterized by indivisibility, expansibility, high transaction costs, and high fixed costs of original production. Agricultural research is the search for knowledge and

6. Schmid (1987) calls the framework the Situation-Structure-Performance (S-S-P) model. The S-S-P model was developed from the Structure-Conduct-Performance (S-C-P) model used in industrial economics to understand how market structure (for example, the number of firms) determines the conduct of firms (for example, pricing) and how market behavior, in turn, affects market performance (for example, technical and economic efficiency). The S-S-P model expands the structural component of the S-C-P model to analyze how varieties of a situation that are determined by the inherent characteristics of a commodity interact with the type of institutional structure to produce the resulting performance.

7. Schmid argues that the situation includes attributes of individuals such as preferences, values, knowledge and decision strategies; attributes of the community such as the number of decision makers and the degree to which individual characteristics are shared; and characteristics of the commodity as determined by its biology and physics. Focusing on the short-run, individual and community attributes are given and unchanging. This permits the analyst to focus on the characteristics of the commodity. These are categorized into seven dimensions or varieties of situations: incompatible use goods; high exclusion costs; economies of scale; joint impact use; transaction costs; surpluses; and fluctuating demand and supply.

the findings that are uncovered by the search are highly uncertain.[8] Therefore, the most relevant attributes for differences between the different FPR approaches are explicitness or implicitness of the knowledge about technology, the transaction costs of observing phenomena, the uncertainty of the technology, and the cumulative and interactive nature of technology generation and dissemination. Modern science-based technologies are organized in codified forms of knowledge such as books, scientific papers, patents, blueprints, and databases. These can be transmitted and received at low cost. Some knowledge is embodied in individuals in tacit and implicit form. Implicit knowledge becomes part of human capital. Implicit knowledge can be transmitted and received at high cost. A lot of indigenous knowledge is implicit knowledge and exchanged by farmers as tacit knowledge through demonstrations, personal instruction, and collective actions that cannot be accomplished by one individual. Nelson (1987) argues that existing technology can be improved in various ways and that there are often several ways to achieve these improvements. However, it is uncertain ex-ante which of the objectives is most worthwhile pursuing and which of the approaches will prove most successful.[9] There are differences of opinion and vision about the structure of the uncertainty.

Agricultural technology grows by learning-by-doing and learning-by-using and this is in part a substitute and in part a complement to learning through research and development. Creation of technological knowledge requires abilities to understand and to undertake research and development, which is a scarce good that can be expanded by suitable training (Arrow 2000). Diffusion of knowledge takes place through imitation based on seeing success of others, public agencies particularly in agriculture, informal communication among different farmers, and forums (conventions, trade meetings, discussion with customers). Geographic proximity and mobility of farmers are important sources of knowledge diffusion. Farmers to whom knowledge is diffused require absorptive capacity to understand and adapt new technologies.

We can hypothesize how these attributes interact with the different FPR approaches and predict their consequences. Table 1 summarizes the varieties of situation, the types of FPR, and the resulting performance. The researcher-led, farmer-managed approach is instrumental in achieving quality management recommendations in the situation of high differentiation of technology but it is not instrumental in the situation marked by high transaction information costs. The

8. This definition follows that of Nelson (1959). Nelson defines scientific research as human activity directed toward the advancement of knowledge. This knowledge consists of two separable kinds: facts or data observed in reproducible experiments and theories or relationships between facts.
9. Nelson (1987) argues that if the research and development allocation problem was simply uncertainty and everybody agreed on the structure of the uncertainty then one could define the problem as a dynamic programing one involving uncertainty and learning. But there are differences of opinion and vision.

researcher-led, researcher-managed approach is instrumental for achieving scientifically robust practical solutions in the situation marked by high transaction information costs but it is not instrumental in devising resource-poor farmer-oriented solutions in the situation of high transaction uncertainty costs because the approach focuses on experiments of scientific significance without consideration of risks. The farmer-led, farmer-managed approach is empowering and cost-effective to achieve the development and dissemination of appropriate practical soil fertility management technologies in the situation in which learning-by-doing is dominant but it is ineffective to achieve generation of adoptable technologies in a situation of high transaction information costs.

Methods to assess the impact of research

The main result of FPR is the generation and adoption of new, appropriate technologies by small, resource-poor farmers that help them solve production problems and increase farm productivity, incomes, and improve economic welfare. The impact of an FPR approach can be measured by the extent to which it affects the final outcomes such as adoption of technologies, improvement in farm yields, incomes, and poverty alleviation. Because there are time lags between initiation of the research and adoption of technologies and changes in yields, there is a need for a flexible and comprehensive mixed method that looks at processes, research output, and potential outcomes rather than focusing solely on actual outcomes.

It is being proposed that the impact of alternative FPR approaches be evaluated in terms of the processes and products by which research and information exchange and learning is carried out using a number of indicators:

- Knowledge of trials and trials result by farmers and extension agents.
- Changes in research and extension practices resulting from scientists' dialogue with farmers.
- Changes in farmer practices, including experimentation and technology being adopted.
- Cost-effectiveness of participatory research method.
- Empowerment, i.e., the degree to which farmers make new demands on research and extension.

Table 1. Interaction of attributes with different farmer participatory research (FPR) approaches.

Situation (Commodity attributes)	Structure (Alternative FPR methods)	Performance (Who gets what)
Explicit (codified) or implicit (tacit) knowledge: Explicit knowledge codified into information; and implicit knowledge like fear and love	Researcher-led, researcher-managed	Scientifically robust recommendations but impractical for farmers to implement; inappropriate technologies.
	Researcher-led, farmer-managed	Both scientific and indigenous knowledge generated; quality and appropriate technologies.
	Farmer-led, farmer-managed	Indigenous knowledge generated; low scientific significance but appropriate technologies.
Transaction information costs: Phenomena easily observed with naked eye and cause and effect relationships straightforward	Researcher-led, researcher-managed	Researcher knowledge precise and correct; single or few ideal recommendations which do not consider resource constraints.
	Researcher-led, farmer-managed	Researchers' and farmers' knowledge precise and correct; series of recommendations.
	Farmer-led, farmer-managed	Farmers' knowledge precise and correct; series of recommendations that fit resource constraints.
Phenomena difficult to observe and multiple casual factors exist	Researcher-led, researcher-managed	Researchers' knowledge precise and correct; quality scientific results but impractical.
	Researcher-led, farmer managed	Researchers' and farmers' knowledge precise and correct; quality and practical technologies.
	Farmer-led, farmer-managed	Farmers' knowledge imprecise, incorrect or non-existent; not technically robust.
Transaction costs: Uncertainty	Researcher-led, researcher-managed	Researchers bottom risk covered; technology evaluated using researchers' criteria; slow adoption
	Researcher-led, farmer managed	Researchers and farmers learn farmers' criteria to cope with risk; resolve uncertainties; moderate adoption.
	Farmer-led, farmer-managed	Farmers assess experiences using their criteria; fast adoption.

continued

Table 1. continued

Situation (Commodity attributes)	Structure (Alternative FPR methods)	Performance (Who gets what)
Cumulative and interactive scientific and technological knowledge grows by incremental additions: Learning-by-doing important as what can be learned in distinct and deliberate research and development	Researcher-led, researcher-managed	One-way (top-down) communication; no empowerment; poor research-extension-farmer linkages; not cost-effective system.
	Researcher-led, farmer managed	Three-way (researcher-extension-farmer communication); limited empowerment; cost-effective system.
	Farmer-led, farmer-managed	Farmer-to-farmer communication; high empowerment; cost-effective system.

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5.3 Targeting of Women Farmers

David Rohrbach[1]

A major objective of this project is to define practical crop management options suitable for poorer, women-headed households. We can view this objective from two different vantage points. First, women-headed households can be viewed as a stratification grouping. In effect, we are assuming that women-headed households have resource levels and farming objectives that differ from those of male-headed households. Therefore, they have differing technology needs. For example, we discussed the fact that *de facto* female-headed households tend to be relatively cash rich. Therefore, these households may be better able to adopt cash demanding soil fertility management technologies like chemical fertilizer. We noted that *de jure* female-headed households tend to be extremely poor, with fewer livestock, cash, and labor resources. These farmers may be relatively more interested in soil fertility technologies such as crop rotations. In contrast, male-headed households tend to have more cattle, and thus may be more likely to use manure.

These distinctions seem to apply in Zimbabwe's Matabeleland but may be more questionable in Masvingo, and in the project areas of Malawi. Perhaps we still need to examine our baseline data for signs of such distinctions. We should also discuss these distinctions with our participating communities. These farmers may identify gender relationships that are not immediately evident in the survey data.

Finally, we need to assess how these distinctions can practically be applied to the targeting of technology diffusion. National research and extension programs are accustomed to developing nationwide recommendations, or at best, those suited to a few grossly defined agro-ecological zones. Is it practical for extension recommendations to be re-targeted by gender as well as agro-ecology? How is this proposition to be tested?

A second basis for targeting the interests of women farmers is to consider the distinction between male and female access to, and control over, resources commonly found in the gender literature. This distinction is essentially one of empowerment.

One objective of participatory research is to empower farmers to assist with the development of technology. Women's needs might best be met if women farmers, in particular, are targeted for empowerment. In effect, we would be aiming to improve the access of women farmers to new soil fertility management technology, and their capacity to employ or control these technologies. This includes the empowerment of women in male-headed households, as well as women managing their own farms.

1. ICRISAT-Bulawayo, P 0 Box 776, Bulawayo, Zimbabwe.

Empowerment training underlies one of the four participatory research models to be compared in this project. Are any efforts being made to empower women farmers in particular? Or are women gaining more than men from the empowerment efforts underway?

In this context, it may make sense for the project to assess the relative involvement of women in farm decision-making, particularly decision-making relating to soil fertility management, the target of this project. Parts of the gender literature argue that the empowerment of women contributes more to improving family welfare than the empowerment of men. Women are more likely to spend time and cash resources caring for children, and are less likely to allocate resources to drinking and recreation. However, this also assumes that women are not simply involved in farm decision-making, but also gain a greater measure of control over some of the products of these farming decisions. If new soil fertility management technologies raise production levels and profits, will these be invested back into the farm and family? Who makes these decisions?

Incorporating the targeting objective into work plans

Such considerations need to be explicitly accounted for during the development of project work plans for the 2000/01 cropping season. Each of these work plans should identify an explicit strategy for accounting for the needs of women farmers. There are many ways this can be achieved. This project has already characterized the resource levels and decision-making responsibilities of male- and female-headed households during the analysis of the baseline survey results. Further analysis of these data may, however, reveal further information about stratification options in particular.

In addition, hypotheses about which soil fertility management technologies will best fit the needs and interests of women should be directly stated in the 2000/01 experimental work plans. At a minimum, the teams might state whether the technologies being tested are perceived to be gender neutral, or whether these are more likely to be useful for male or female farmers. How can this be tested?

Women farmers can be specifically targeted as participants in the on-farm trials. They may be specifically targeted as participants in discussions of trial designs and technology choice. In some communities, experimentation might be sought with separate groups of male and female farmers. The results can then be compared though the justification for these decisions would have to be carefully discussed with the communities.

The project aims to evaluate alternative participatory research methods. In this context, it should consider whether one or another method is more beneficial to women farmers. Perhaps empowerment efforts particularly benefit women by explicitly encouraging their integration into group decision-making. But empowerment may be less helpful if men control the 'empowered' farmer groups. Are there specific methods of interaction most likely to elicit women's opinions about technology options? Can these considerations be incorporated into the 2000/01 work plans to ensure we have a clear set of observations, and perhaps lessons, when we meet next year?

Finally, the project will need to characterize and measure the unique impacts of its efforts on men and women farmers. This includes the assessment of the hypotheses about which technologies are more beneficial to men and women farmers. But the impact assessment should also seek signs of whether women farmers are learning more, or are quicker to start adopting some of the soil fertility management technologies being tested. While the project cannot expect to measure adoption rates per se, the project team should watch for signs of particular success with women farmers.

All of the project's team members need to contribute to these endeavors. The targeting of women farmers cannot be simply viewed as an impact indicator to be evaluated at the end of the project. Rather it encompasses hypotheses to be tested from the very beginning of the experimentation. These hypotheses have not been as explicit as they might have been during the first year of the effort. They ought to be made more explicit in this year's work plans.

6. Presentations of 2000/01 Work Plans

6.1 Summary on the Activities and Follow-up Actions Agreed on to Further Develop and Enhance the Work Plans

The purpose of this session is to record the comments and actions agreed to further develop and enhance the work plans presented by:
Bernard Kamanga (BK) (CIMMYT) for the Chisepo area of Malawi
Jacob Mapemba (JM), Concern Universal, Dedza
Jean Nzuma (JN) (DR&SS) and Herbert Murwira (HM) (TSBF) - Manure trials in Tsholotsho
Geoff Heinrich (GH) (ICRISAT SMIP), Gwanda (in collaboration with ITDG and Agritex) and Tsholotsho
Lucia Muza (LM) (DR&SS) - Weeding x nitrogen trials and legume trials in Zimuto and Tsholotsho
Joseph Rusike (JR) (ICRISAT) - Impact monitoring
John Dimes (JD) (ICRISAT) - Modeling

Bernard Kamanga - Chisepo

- The farmers in this area have been exposed to three consecutive years of mother-baby trials and a series of farmer initiated activities with legumes and green manures. Given current funding constraints, activities will concentrate on monitoring farmer activities and adoption patterns using various techniques. At present there are no plans for a researcher-managed trial in this area.
- The project will facilitate farmer access to seeds on a cost recovery basis.
- Using the baseline survey BK in collaboration with Ade Freeman (AF), David Rohrbach (DR), and JR will develop hypotheses that will form the basis of surveys in the area during the 2000/01 season.
- AF to provide copy of completed baseline survey analysis by 15 October 2000. Initial tables from analysis to be provided next week.
- Budget estimate for activities is US$ 2500.
- If extra funding becomes available before the time of planting it is recommended that at least one version of the original mother trial should be planted in the area.
- BK to revise work plan based on the discussions held and indicate dates when the proposed outputs for each activity will be made.
- Once work plans are available S J Twomlow (SJT) and JR to develop own work plans for site visits, if funds permit.

Jacob Mapemba, Concern Universal, Dedza

- Work plan was modified to reflect the reduced funding (US$ 6500) available.
- Bob Myers to check the status of the Scientific Officer position in Malawi next week on his visit to India. It is hoped that if the position is still live recruitment will take place as quickly as possible and the officer will provide scientific support to Concern.
- Once work plans of all the collaborators have been finalized SJT and JR to arrange visit to Malawi to provide training in participatory farming research techniques and research management, if project funds permit.
- JM to revise work plans to reflect discussions and comments from this session and indicate dates when the proposed outputs for each activity will be made.

Jean Nzuma (DR&SS) and Herbert Murwira (TSBF) - Manure trials in Tsholotsho

- Site locations will be confirmed by the end of September when HM has confirmation of his core funding from TSBF.
- The number of sites/farmers that will host trials during the 2000/01 season needs to be confirmed.
- Some of the planned trials on the interaction between manure and inorganic fertilizers could be considered to be integrated with the sole manure trials using a split plot technique.
- Close collaboration on all proposed survey work is required with JR to ensure that there is a consistency in data collection. Such collaboration will also ensure that unnecessary visits to farmers are avoided.
- Bob Myers expressed an interest in the interactions between soil type and responses to manure. This interest needs to be followed up and developed further if possible.
- Within the work plans some activities need to be directed towards looking at the residual impact of manure on trial sites during the previous season.
- Discussions are required between JN and GH to identify areas of complementarity and where activities might be shared. It was agreed that JN and GH would meet on 15 September 2001 to explore this opportunity for collaboration with and support from SMIR.
- JN to revise work plans to reflect discussions and comments from this session and the meeting with SMIP and indicate dates when the proposed outputs for each activity will be made.
- Budget estimated at US$ 8700. Once work plans are available SJT and JR to develop own work plans to facilitate site visits, if funds and fuel availability permit.

Geoff Heinrich (ICRISAT SMIP) - Gwanda (in collaboration with ITDG and Agritex) and Tsholotsho

- GH to provide summary work plans. These will reflect the area of complementarity with the manure work outlined earlier.

Discussion between Jean Nzuma and Geoff Heinrich

- GH and SMIP may take up some of the manure management studies in Tsholotsho. We agree that if this happens, we may split the trials, with maize and some white sorghum.
- JN will get her enumerator to check which farmers have treated manure, and then we we will decide how to split up the work. SMIP may be requested to take over manure management and manure x nitrogen trials for Ward 13 and maybe other locations.
- TSBF plan to concentrate in Godzo and conduct trials on:
  - Manure application rates.
  - Residual effects of farmyard manure.
  - Winter plowing and manure vs heap + pit.
- SMIP and TSBF agree to hold farmer meetings together. Planning meetings, field days, and farmer feedback meetings will be held together and the meeting dates will be agreed upon in advance.
- GM to provide JN with a copy of the Farmer Field School (FFS) curriculum (when received from UZ). We will then look for opportunities to develop input from JN and TSBF in the FFS program. Visits to the FFS in Tsholotsho can be covered from the Rockefeller budget, and help to offset travel costs for the DFID project.
- The 1st Planning Meeting in Tsholotsho will be held in the 2nd week of October 2000. JN and GH to liaise on specific days.

Lucia Muza (DR&SS) and John Dimes (ICRISAT) - Weeding x nitrogen trials and legume trials in Zimuto and Tsholotsho

- Budget estimate of US$ 6050 based on one traditional trial of nitrogen x frequency of weeding at both Zimuto and Tsholotsho. In addition a researcher-managed trial in Zimuto will be conducted to monitor the residual impact that legumes established in the previous season.
- The proposed work will verify the work of first year of trials.
- The baby trials implemented at both sites last season will not be implemented this season given the budgetary constraints.

- However, to ensure some continuity with farmers who hosted baby trials in Zimuto last season, JD proposes to work with these farmers using model simulations to develop possible follow-up experiments. All baby trial farmers will be allocated seed and fertilizer to do their own experiments. What they actually do will be monitored during the season.
- LM to revise work plans to reflect discussions and comments from this session and indicate dates when the proposed outputs for each activity will be made.
- Once work plans are available SJT and JR to develop work plans to facilitate site visits, if funds and fuel availability permit.

Joseph Rusike (ICRISAT) - Impact monitoring

- Finalize work plans and visits once work plans from all collaborators are available.
- Ensure linkage with all proposed survey work so that there is no unnecessary duplication of efforts.

Steve Twomlow, Project Manager

- To liaise with all collaborators and develop own work plan that facilitates above activities and ensures that project outputs are met on time.
- Continue to explore avenues for additional funds and resources.
- In collaboration with Bob Myers follow up replacement of Scientific Officer in Malawi.

6.2 Dedza (Malawi)

Planned activities for April 2000 to March 2001

The soil fertility management options are giving promising results. The results show that more and more farmers want to try the soil fertility management options. During the 1997/98 growing season, 5 farmers were involved in the trials. During 1998/99 and 1999/2000, the number of farmers increased to 23 and 44 respectively. Concern Universal, Dedza, Malawi in partnership with ICR1SAT will work in 6 villages:

- 4 trial demonstration villages
- 1 research-led village (if Scientific Officer is available)
- 1 farmer-led village

During the 2000/01 growing season, emphasis will be on empowering the communities to design, implement, monitor, and evaluate their own trials. Hence, during this period, the activities emphasize on:

- Training for transformation.
- Participatory rural appraisals (PRAs).
- Training in farmer participatory research methods.
- Training in monitoring and pair-wise ranking and meetings with various village structures on approaches to initiate soil fertility management experimentation, demonstrations, and dissemination.

Specifically, during 2000/01, Concern Universal in collaboration with ICRISAT aims at:

- Farmer participatory research on some of the soil fertility management options in new villages.
- Demonstrations of promising options in both old and new villages through field days and exchange visits.
- Dissemination of options to more farmers within and outside Bembeke Extension Project Area (EPA).
- Participatory monitoring and evaluation.

Purpose

- To empower the communities to design, implement, monitor, and evaluate their own trials.

Outputs

- Community capacity to design, implement, monitor, and evaluate their own experimentation and demonstrations developed and strengthened.
- Promising soil fertility management options disseminated.
- Farmer participatory research on soil fertility management options conducted and demonstrated.
- Participatory monitoring and evaluation of soil fertility management options conducted.

Key strategy actions

- Gender training.
- Training in farmer participatory research methods.
- Leadership and group dynamics training.
- Training for transformation (TFT).
- Training in participatory monitoring and evaluation.
- Conduct field days.
- Training in research design and management.

Budget

Proposed activities	Time period	Inputs	Budget (US$)
PRA on farmer perceptions about institutions, management of crops, soil fertility improvement, and resources	Sep 2000	Stationery, facilitators	500
Training in farmer participatory research methods	Aug 2000	To be organized by ICRISAT office	
Identify groups existing in the villages and discuss with them approaches to initiate soil fertility management experi-mentation, demonstrations and mother/baby trials	Sep 2000	Stationery, refreshments	100
Conduct TFT in second farmer-led village	Oct 2000	Stationery, meals, accommodation allowances	500

continued

continued

Proposed activities	**Time period**	**Inputs**	**Budget (US$)**
Conduct training in research-led village to facilitate trial monitoring and recording by farmers and pair-wise ranking	Oct 2000	Stationery, meals, accommodation, allowances	500
Facilitate access to inputs	Nov 2000	Seed, fertilizer	500
Facilitate field days (participatory monitoring)	Feb 2001	Transport, meals, accommodation	1000
Harvesting of trials	Mar 2001	-	-
Participatory evaluation of trials	Mar 2001		500
Report writing	Apr 2001		100
Administration costs	On-going		600
Pay salaries to enumerator and supervisor	Apr 2000 to Mar 2001	Salaries and allowances	2500
Total			6800

6.3 Chisepo (Malawi)

Work plan

Objectives	Activities	Methodology	Expected output	Timeframe
Literature review	Review of secondary data on comparison activities	Review of secondary data from libraries	Document of relevant literature	Oct-Dec 2000
To train farmer on data recording and observation	Farmer observations	Group training of farmers	Farmers know what to observe in the trials	Oct-Dec 2000
Identify constraints of production for women farmers	Participatory rural appraisal (PRA)	Farmer group discussions	Document of production constraints	Oct-Dec 2000
Identify farmer profiles	PRA	Group meetings for wealth ranking	Farmer classes defined	Oct-Dec 2000
Incorporate legume biomass	First year legume biomass incorporation	Use farmers to do the work	Prepared for the second season	Sep 2000
Trial setting	Implementation of trials for the second season	Plot mapping and pegging	Farmers ready for early planting	Sep 2000
Establish initial soil conditions	Soil sampling	Use of the Soils Department of Bunda College	Soil database developed	Sep-Oct 2000
Training of enumerators	Training in data collection sheets	Enumerators called for meeting	Knowledge on data collection sheets and techniques	Oct 2000

continued

continued

Objectives	Activities	Methodology	Expected output	Timeframe
Trial establish-ment	Planting of maize and legumes	Farmers and enumerators	Trials implemen-ted	Sep 2000
Trial monitoring	Planting, fertilization, data collection	Use of enumerator, frequent visits by researchers and collaborators	Clean and meaningful data	Oct 2000 (ongoing)
Farmer appreciation	Field days	Farmers within the villages	Farmer perceptions	
Establish soil condi-tions in mid-season	Soil sampling	Use of Bunda College	Soil database	Oct 2000
Define indicators	Comparing resource flow maps	Use of resource flow maps to generate indica-tors for method comparison	Well defined indicators	Dec 2000 to Feb 2001
Identify resource use deci-sions	Resource maps development and establishment of decisions	Participatory household budget-ing, enumerators recording resource flow in the house-hold and decisions behind allocation	Detailed flow of resour-ces and decisions	Oct 2000 (ongoing)
Farmer apprecia-tion of trials	Field days organized	Farmers in each village visit the trials	Farmer perceptions and their input to the process defined	Jan 2001
Harvesting				Apr/May 2001
Data entry and analysis				Jun/Jul 2001

continued

continued

Objectives	Activities	Methodology	Expected output	Timeframe
Identify farmer views on yields	Feedback to farmers	Visual translation of results for farmers' observations	Farmer questions and input for modifica- tion defined	Jul/Aug 2001
Reporting	Write up of report	Organization of data and interpretation	Publication	Aug/Sep 2001

Budget for 2000/01 crop season

		Estimated cost[1]	
Item	**Details**	**MK**	**US$**
Literature review	Contract 1 person	8,000.00	126.98
	Communication	2,000.00	31.75
	Stationery	400.00	6.35
Farmer training		30,000.00	476.19
Inputs	Maize seed MH 18	3,324.00	52.76
	Legumes:		
	Pigeonpea	1,200.00	19.05
	Mucuna	1,000.00	15.87
	Groundnut	2,000.00	31.75
Vehicle	Fuel and oils	30,000.00	476.19
Field days	Farmers (3)	15,000.00	238.10
	Researchers (1)	6,000.00	95.24
Field allowances		30,000.00	476.19
Field PRAs	Details of socioeconomic data	90,000.00	1428.57
Data organization	Entry, analysis, and	8,000.00	126.98
	reproduction	12,000.00	190.48
	Stationery	2,000.00	31.75
	10% contingency	25,000.00	396.83
Grand total		265,924.00	4221.03

1. The initial budget of US$ 2550 stands but for full work this is the reasonable budget.

6.4 Tsholotsho (Zimbabwe): Manure Management

Farmer participatory experimentation in Tsholotsho - 2000/01 season

- We had initially planned to work in both Shurugwi and Tsholotsho, Zimbabwe. Dr Steve Twomlow suggested that we should concentrate in areas where ICRISAT has on-going work; hence, we will cut down the work in Shurugwi.
- All trials for the 2000/01 season will provisionally be implemented in Godzo (Ward 13) where our enumerator/research assistant lives so that she can effectively monitor trials hosted by women farmers there. This will strategically cut down on transport costs considering the limited funding.
- Work in other villages will be confirmed by the end of Sep 2000 when Dr H K Murwira has confirmation of his core funds from Tropical Soils Biological Fertility (TSBF).

Activities/Participatory Adaptive Trials (PATs) for 2000/01 season

- We will continue with work implemented during the first season.
- New work is based on modifications from first season's work.
- We will explore residual effects of manures applied during the first season and other alternatives proposed by farmers.
- Trial designs will be both researcher and farmer managed.

Activity 1

- Farmers will continue evaluating crop responses from manures of different quality, i.e., from different storage systems on sandy and clay soils. The 1999/2000 season was wetter than previous seasons and farmers argued that it was not an ideal season for evaluating manure storage technologies.
- To assess the residual effects from previous manure applications.

Treatments:
1. Control
2. Heap manure (uncovered)
3. Heap manure (covered)
4. Pit manure

Activity 2

Farmers will continue evaluating various application rates of manure on light and heavy textured soils to come up with precise recommendations suitable for their agro-ecological zone and soil types.

Treatments:

1. Control
2. 3 t ha^{-1} manure
3. 6 t ha^{-1} manure
4. 9 t ha^{-1} manure
5. 12 t ha^{-1} manure
6. 15 t ha^{-1} manure

Activity 3

Farmers would like to evaluate the effect of winter plowing or plowing with undecomposed manure on crop growth and yield. This treatment will be compared to previous storage treatments.

Treatments:

1. Control
2. Undecomposed manure incorporated through winter plowing
3. Practice
4. Heap manure (uncovered)
5. Heap manure (covered)
6. Pit manure

Activity 4

Women farmers with no access to manure would like to evaluate other alternative strategies for soil fertility management.

Treatments:

1. Control
2. Compost
3. Leaf litter
4. Anthill

Activity 5

Farmers would like to determine effect of combining manure with inorganic fertilizer nitrogen sources on crop growth and yield.

Treatments:
1. Control
2. Heap manure + fertilizer
3. Pit manure + fertilizer
4. Fertilizer alone

The actual quantities of manure and fertilizer shall be based on previous work done in Shurugwi and Mrewa which is already documented. We shall synthesize the results to come up with a protocol that farmers can test.

Activity 6

A follow through survey to determine adoption of manure and labor profiles shall be conducted in collaboration with ICRISAT economist (Dr J Rusike) and TSBF economist (Mr K Mutiro). This survey will use the proposed impact indicators as guideline. Some trials will be implemented by SMIR.

Plan of activities for Tsholotsho, 2000/01

Month	Activity
Oct	Planning workshop
Nov	Planting
Dec	Fertilizer application (first split)
Jan	Fertilizer application (second split)
Feb	Mid-season evaluation with farmers in their fields. Hold a field day (subject to availability of extra funds from TSBF/SMIP)
Mar	Compile first report
Apr	Harvesting
May	Analysis of data and write up of data
Jun	Develop/design leaflets
Jul	Farmer feedback meeting
Aug	Prepare report from feedback meeting
Sep	Compile final report

Budget

- TSBF and Department of Research and Specialist Services (DR&SS) will provide salaries for researchers. One research assistant will be paid from DFID project funds.
- Research expenses will include:
  - Casual labor field supplies, e.g., fertilizer, sample bags, seed input, and insecticides.
  - Purchasing of tillage implements, e.g., hoes and shovels.
  - Chemicals and lab supplies.
- Travel and subsistence allowance (T&S).
- Field allowances for scientists at per-diem rates.
- Provision is made for the following field visits:
  - Planning workshop, set up storage systems and composts.
  - Planting, monitor crop emergence, monitor fertilizer application, harvesting, and feedback meetings.
  - A follow through survey.
- Vehicle hire and purchasing of petrol.
- Publications (production of papers, report, and leaflets).

Budget for 2000/01 season

Item	2000/01 (US$)	Sep 2000 to Mar 2001 (US$)	Apr 2001 to Sep 2001 (US$)
Research assistance	1200	600	600
Research expenses	2000	1500	500
Travel (T&S)	2000	1500	500
Vehicle hire	3000	2300	700
Leaflets	500	500	-
Total	8700	6400	2300

6.5 Nitrogen x Weeding Trials and Legume Trials in Zimuto and Tsholotsho in Zimbabwe: 2000/01 Work Plan

Objective: To verify 1999/2000 season results on the nitrogen (N) x weeding trial and to find the effect of 1999/2000 legumes on the subsequent maize.

Trial design: Only main trial with three replications at a site

Trial management: Researcher managed

Treatments:

1. Weeding time
   a) Weeding at 4 weeks after crop emergence
   b) Weeding at 2 and 6 weeks after crop emergence
2. N rate
   a) 0
   b) 1 bag ammonium nitrate (AN) (17.25 kg N ha^{-1})
   c) 2 bags AN (34.5 kg N ha^{-1})
   d) 3 bags AN (51.75 kg N ha^{-1})

Sites: Zimuto-Mahoto and Tsholotsho-Mkhwananzi line

Chart of activities for 2000/01

Month	Activity
Oct	Feedback workshop with farmers and planning for the coming season
Nov	Planting, soil sampling
Dec	Weeding and stalk borer control
Jan	Fertilizer application
Feb	Weeding, soil sampling
Mar	Field days
Apr	Harvesting
May	Result analysis
Jun	Result analysis
Jul	Report writing
Aug	Report writing
Sep	Final report presentation

Budget

Item	Total cost estimate (US$)	Sep 2000 to Mar 2001 (US$)	Apr to Sep 2001 (US$)
Travel (car hiring and air tickets to Bulawayo)	900	600	300
Travel and subsistence allowance	1000	800	200
Inputs and chemicals	400	400	0
Consumables	100	100	0
Workshops/field days	1000	500	500
Communication	100	50	50
Soil analysis	2250	2250	0
Labor	300	200	100
Total	6050	4900	1150

7. Reporting Targets and Formats

7.1 Outline Format for Guidelines

A discussion on how work plans need to meet project objectives and outputs was opened by the facilitator. This was followed by the presentation of an outline format for guidelines. Issues that need to be considered under the guidelines were listed.

Outline format for guidelines:

1. How was the area selected?
2. Entry procedure
3. Farmer selection
4. Background appraisals
5. Selection of treatments - testing, empowerment
6. Who designed the trials?
7. Trial monitoring
8. Interactions
9. Target women or poor households
10. Feedback of results
11. Trials modified in year 2

Researchers in the project were then asked to discuss and present how they planned, set up, and implemented their trials in relation to the guidelines. Tables 1 and 2 summarize the methods used by researchers at the different sites.

(Note: In Tables 1 and 2, PRA denotes participatory rural appraisal; and FHH denotes female-headed households.)

Table 1. Methods used in study areas – Dedza, Chisepo, and Tsholotsho.

Item	Dedza (Malawi)	Chisepo (Malawi)	Tsholotsho – Manure management
1. How was the area selected?	• Villages without projects • PRA results • High number of FHH	• Baseline survey • PRA	• Dry area • ICRISAT area
2. Entry procedure	• Meetings (Concern Universal well known)	• ICRISAT/CIMMYT sites	• Meetings with farmers • Consultation with extension
3. Farmer selection	• Voluntary • Research chosen (middle aged)	• FHH • Voluntary	• Farmers selected each other
4. Background appraisals	• PRA	• Ongoing work	• Existing data used • PRAs
5. Selection of treatments, testing, empowerment	• Researchers selected treatments • Farmers chose options	• Ongoing work • Demand from farmers	• Options given to farmers and farmers chose according to their means
6. Who designed the trials?	• Researchers • Farmers (options)	• Researchers • Farmer input in farmer-led villages	• Researchers
7. Trial monitoring	• Enumerator • Field visits/days • Meetings	• Field book • Visits • Field days	• Enumerator and extension • Researchers • Farmers
8. Interactions	–	–	• Between 4 and 5
9. Target women or poor households	• Yes; village with higher percentage of women	–	• Women invited to meetings • Women encouraged to participate
10. Feedback of results	• Meetings • Field days	• Presented to farmers	• Meetings • Field discussion during season
11. Trials modified in year 2	• Yes; seed shortage	• No	• Last year's trials to continue

Table 2. Methods used in study areas – Tsholotsho, Gwanda, and Zimuto.

Item	Tsholotsho – N × weeding	Gwanda	Zimuto – FPR groups
1. How was the area selected?	• Low rainfall • Low soil fertility	• Semi-arid area • Sorghum and millet growing areas • Consultation	• Proximity to Makoholi Research Station • No previous technology trials
2. Entry procedure	• Ward meeting, through CARE and Agritex	• Baseline survey • Stakeholders' workshops • PRAs	• Meetings • PRA
3. Farmer selection	• Farmers chosen by fellow farmers	• Vounteers	• Agritex • Volunteers
4. Background appraisals	• Old appraisals used	• Baseline surveys • PRAs • Existing data	• PRAs • Field days
5. Selection of treatments, testing, empowerment	• Model outputs • Extension and research recommendations • Farmer's practice	• Researcher selected	• Key informants
6. Who designed the trials?	• Researchers	• Researchers	• Year 1 Researcher • Year 2 Mother/baby • Year 3 Agritex Demonstration • Year 4 Farmer led
7. Trial monitoring	• Trial visits • Enumerator • Field days	• Enumerartor • Researcher visits • Farmers	• Enumerators assisted farmers
8. Interactions	• Interaction between 4 and 5	–	• Enumerators assisted farmers

continued

Table 2. continued

Item	Tsholotsho – N × weeding	Gwanda	Zimuto – FPR groups
9. Target women or poor households	• Invited to meetings • Invited to field days	• All farmers included • Growing legumes	• Farmer hosts modified • Poorer households are women
10. Feedback of results	• Meetings • Field days	• Field days • Feedback workshops	• Meetings
11. Trials modified in year 2	• Yes, due to lack of funds	• Yes	–

7.2 Reporting Procedures

Summary of Discussions on Reporting Procedures and Authorship as agreed at Stakeholders' Planning Workshop, 13-15 September 2000, ICRISAT-Matopos

To: Lucia Muza, Jean Nzuma, Herbert Murwira, Bernard Kamanga, Jacob Mapemba, Geoff Heinrich
From: Steve Twomlow and Joseph Rusike

6-monthly report 15 March 2001

As agreed in the planning meeting collaborators will provide Project Management with a brief one to two page summary report of progress against the agreed work plans. These will then be incorporated into the 2nd Annual Project Report to be completed by the Project Management by 31 March 2001, for submission to the donor in April 2001. A suggested format is attached and should be accompanied by copies of any reports or publication that have originated from this work (see Format).

Final report 30 August 2001

As discussed and agreed at this planning meeting, collaborators will provide a Final Technical Report on their activities funded under this project. A draft report is required by 30 August, prior to the final project workshop in September 2001. Project Leaders are encouraged to prepare a report that can be published as an ICRISAT Working Paper, that will be subject to internal review. Each report should include an annex of data collected. A payment of US$ 100 will be made to Project Leaders, to help defray costs incurred in final report preparation, on acceptance of the report. A draft outline is attached for comment by Project Leaders (see Draft outline for final technical report). All comments should be sent to the Project Management by March 2001 so that a final outline can be circulated in April 2001.

Project reports

It was agreed that copies of all internal project reports will be provided to the Project Management to assist in reporting to the Donor.

Journal and conference papers

- All project collaborators are encouraged to disseminate the results from their own work as widely as possible through conference and journal papers.
- Authorship: Concerns were expressed over rights of authorship, especially in joint publications, and through discussions it was agreed that the lead author would be the person that writes the first detailed draft of a paper.

Acknowledgments

It is essential that documents published from this work should include an acknowledgment to the organizations that funded this work; i.e., "This research was partially funded by the UK Department for International Development's (DFID) Renewable Natural Resources Knowledge Strategy, 'Project R7260 (C) Will Women Farmers Invest in Improving their Soil Fertility Management? Participatory Experimentation in a Risky Environment', managed by SADC-ICRISAT in cooperation with the Government of Zimbabwe (GoZ), etc. However, DFID, GoZ, and ICRISAT can accept no responsibility for any information provided or views expressed, as they are purely the authors."

Format

Period under report: October to March 2001

DFID Contract Number: R7260 (C)

Main Project Title: "Will Women Farmers Invest in Improving their Soil Fertility Management? Participatory Experimentation in a Risky Environment"

Project Title: e.g., Best Bets APSIM Modeling Scenario Analysis on Short-term Maize Nitrogen Fertilizer Recommendations

Project Leader/Institution: Lucia Muza, DR&SS
Counterpart Institution and Staff: ICRISAT - John Dimes

Start Date: 01/10/2000
End Date: 30/09/01
Budget (i.e.-, Total cost): US$ 6050

Forecast by quarter of expenditure in the current financial year in US$

	Q1	Q2	Q3	Q4	Total
Forecast		4900		1150	6050
Actual	?		?		

Achievements during the reporting period against work plan milestones with actual dates (Please report against each of the activities outlined in your agreed workplan.)

1. Feedback workshops, date, number of farmers (men and women), report and when due
2. Trial establishment - date, etc.; number of sites, type of trials, i.e., researcher, farmer, etc. and treatments; host of trials - number of men and women
3. Trial management and any initial treatment responses
4. Field days, date, number of farmers (men and women) attending; date report due

Collaboration with other projects

Project has carried out a number of joint field days at which Agritex and NGO staff have been in attendance; or, the work is complementary and providing support to activities in Shurugwi.

Dissemination outputs

Type of report	Citation details	Yes/No*
Internal Reports	Twomlow, S.J., Ellis-Jones, J., Chivinge, 0., and Riches, C. 1999. Project Initiation Workshop (9-10 Nov 1999) - Weed management options for cotton based systems of the Zambezi valley. Report IDG/99/20. Silsoe Research Institute, Silsoe, Bedford. 42 pp.	No
Internal Reports	Muza et al. 2000. Feedback Workshop	No
Conference Paper	Muza, L., and Rusike, J. 2000. The synergies between weeding and nitrogen use for smallholder farmers. A case study from Zimbabwe. CIMMYT Regional Workshop. Paper submitted.	No

* *Please state whether the output has previously been reported (e.g., as "submitted", "in preparation ", etc.).*

Highlights of achievements during quarter under report

- Feedback workshop was well attended by farmers in project areas and subsequent field visits and discussions with trade store owners indicated that more farmers are buying nitrogen fertilizer.

Signed:...Date: ....

Draft outline for final technical report

Rubric: Report should be prepared using Times Roman 12 point, single-spaced with a margin of 2.5 cm. All tables and figures should be included in the text.

Contents

- Table of contents.

Executive summary

- Includes the reasons/need for the work.
- Key objectives and methodological approach, i.e., researcher-led adaptive.
- Key results and their implications for future work or dissemination.

Introduction/Background

- Technical/social/economic background of the work.
- Brief summary of past work.
- Purpose of the work being reported (objective/aim) and methodological approach used:
  - Fundamental Research
  - Applied Research (Verification Trials)
  - Adaptive Research
  - Extension orientated activities.
- May include some statement about the level of farmer involvement.

Materials and methods

(*suggested order which will vary with each project)*

- Targeting of research area - location, soils, climate.
- Entry procedure.
- Selection of farmers - Did this include specific targeting of women? Numbers of farmers hosting trials and sex/resource status.
- Selection of treatment - this may relate to last methodological approach (see above).
- Background appraisals - formal surveys, PRAs (Were these done prior to the commencement of work, i.e., using information from other projects, or used to help define problems in area and work to be carried out, or used to help monitor changes in farming practice as a result of the work?).
- Trial design - who designed - this may relate to last methodological approach (see above). Was the trial design the same for period reported or was it changed? If so, why?

- How were the trials monitored and who did monitoring?
- Interactions on results - farmer field days, focus groups discussions, etc.

Results and discussion

- Brief description of environment and rainfall during the study.
- Brief description of socioeconomic status of households and resources, if applicable.
- Trial results and reasons why design modifications undertaken.
- Results from any survey work undertaken and the implications of the research undertaken.

Conclusions

- Implications of research results on project objective/aim.
- Lessons learned during the work and how it might be modified and improved.
- Future work and suggested method to improve future work.

References

Literature cited in report.

Peer reviewed journal papers and edited conference/workshop proceedings

Outputs from project work.

Unpublished reports and presentations

Papers presented at the planning workshop, etc.
Survey reports.

Internal reports

Work plans, etc.
Visit report.
Reports of farmer field days, etc.

Raw data

Spreadsheets of data or input files used for statistical analysis.

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About ICRISAT

The semi-arid tropics (SAT) encompasses parts of 48 developing countries including most of India, parts of southeast Asia, a swathe across sub-Saharan Africa, much of southern and eastern Africa, and parts of Latin America. Many of these countries are among the poorest in the world. Approximately one-sixth of the world's population lives in the SAT, which is typified by unpredictable weather, limited and erratic rainfall, and nutrient-poor soils.

ICRISAT's mandate crops are sorghum, pearl millet, finger millet, chickpea, pigeonpea, and groundnut; these six crops are vital to life for the ever-increasing populations of the SAT. ICRISAT's mission is to conduct research which can lead to enhanced sustainable production of these crops and to improved management of the limited natural resources of the SAT. ICRISAT communicates information on technologies as they are developed through workshops, networks, training, library services, and publishing.

ICRISAT was established in 1972. It is one of 16 nonprofit, research and training centers funded through the Consultative Group on International Agricultural Research (CGIAR). The CGIAR is an informal association of approximately 50 public and private sector donors; it is co-sponsored by the Food and Agriculture Organization of the United Nations (FAO), the United Nations Development Programme (UNDP), the United Nations Environment Programme (UNEP), and the World Bank.

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