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The Soil Fertility Management and Policy Network
for Maize-Based Farming Systems in Southern Africa

SOIL FERT NET ANNUAL REPORT FOR 2003

Stephen R Waddington and Mulugetta Mekuria
Network Coordinators

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CIMMYT

CIMMYT Maize and Economics Programmes

THE SOIL FERTILITY MANAGEMENT AND POLICY NETWORK FOR MAIZE-BASED FARMING SYSTEMS IN SOUTHERN AFRICA

"Soil Fert Net"

Annual Report for 2003

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Contents

Introduction

Our Annual Report for 2003 covers the final year of the Soil Fertility Management and Policy Network for Smallholder Maize-Based Farming Systems in Southern Africa (Soil Fert Net). Funding from the Rockefeller Foundation for the period 1 December 2002 to 30 November 2003 was US$ 396000. Those funds supported a full time agronomist and 50% time agricultural economist to coordinate the network from the CIMMYT Southern Africa office, several ancillary staff and a wide range of networking, research and promotion activities.

With the Soil Fert Net closing after eight years, the Co-coordinators wish to thank the Rockefeller Foundation Food Security Program (and before that its Agricultural Sciences Program) for the financial and other encouragement that allowed the many activities of Soil Fert Net to become reality throughout those years. This has made a real difference to the region. The future is very bright indeed for a broader Soil Fertility Consortium described later in this report.

In the report this year, we examine the legacy of Soil Fert Net and its contribution to future initiatives on soil fertility in southern Africa. Later sections highlight important network research on biophysical and socioeconomic aspects and describe networking events. Table 1 lists major Network events held during the report period.

Soil Fert Net Benefits and Legacy

Figure 1 graphs the yearly trends from 1995 through 2003 in membership, numbers of participants at our workshops and conferences, those that traveled on field tours, and the number of publications produced by Soil Fert Net.

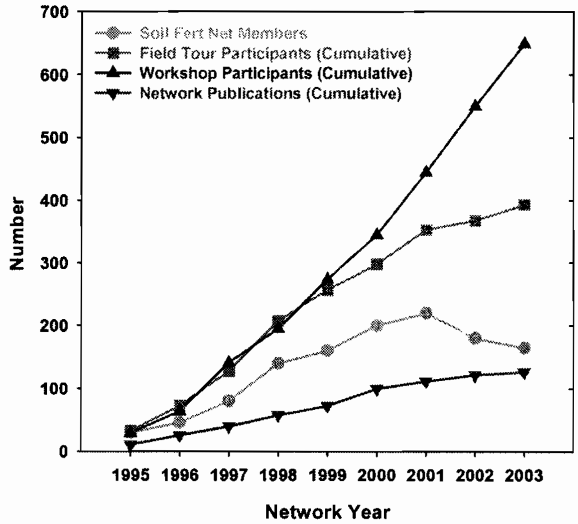

Figure 1. Soil Fert Net membership trends, field tour and workshop participation, and publications from 1995 to 2003

The Soil Fert Net legacy is substantial. We believe benefits and impacts have included:

- ⇨ Far greater awareness of soil fertility constraints, benefits and limitations of interventions on smallholder farms.
- ⇨ Improved science on soil fertility in maize systems which has produced far more biophysical and socio-economic research results relevant to smallholder farms.
- ⇨ Large range of Best Bet soil fertility technology options developed and tested on farm, and now available.
- ⇨ Better understanding of economic performance, integration into farms and adoption issues with soil fertility technologies.
- ⇨ The potential profitability and sustainability

Table 1. Soil Fert Net Workshops and Field Tours completed in 2003

Event	Participants[1]	Location	Dates
Mini Field Tour	18	Central Malawi	9-13 March
Looking to the Future of Soil Fert Net	19 (28)	Harare, Zimbabwe	9-11 June
Soil Fertility and Food Security for the Poor in Southern Africa: Technical, Policy and Institutional Challenges (25th International conference of Agricultural Economists Mini Symposium)	8 (25)	Durban, South Africa	19-20 August
Enhancing the Adoption of Soil Fertility Management Technologies for Sustainable Food Security in Southern Africa: The Role of Policy Instruments and Advocacy	37	Kabwe, Zambia	24-28 November

[1] Sponsored by Soil Fert Net (Total number of participants in brackets)

and limitations of best bet options have been demonstrated through finanical and risk analysis exercises.
- ⇨ These options promoted and generated farmer interest in and use of some of the technologies.
- ⇨ Beginning to demonstrate technology adoption by client farmers and improved food security and livelihoods.
- ⇨ New methods (models, participatory, etc) exposed to membership through training, including socio-economic capacity building.
- ⇨ Contributed to creation of a critical mass of scientists, extension staff and other partners to work on one of the most important constraints of food production in the region.
- ⇨ Comprehensive and integrative network activities established and remain that improved the efficiency of research and extension institutions, universities, NGOs.
- ⇨ Enhanced partnership with diverse membership, collaboration and integration and co-learning among members because of expected benefits and spillovers.
- ⇨ Mobilized additional funding resources for network members.
- ⇨ Enhanced members' capacity to undertake multidisciplinary research, articulate soil fertility problems and solutions to policy makers.

Soil Fert Net Publicity and Partnership

During the report period, Soil Fert Net was promoted by CIMMYT as a good example of the benefits to be gained through integrated networking and partnership. Mike Listman, a CIMMYT Science Writer traveled in Southern Africa during April and May, 2003 to collect stories on Soil Fert Net. These were used in several ways.

Soil Fert Net was used as an example in the development of CIMMYT's new Strategic Plan to illustrate the type of partnership that CIMMYT wishes to develop more frequently. The network was also recommended to FARA to be considered in relation to the Africa Challenge Programme.

Soil Fert Net was featured as CIMMYT's contribution to the 2002 CGIAR Annual Report in an article titled "Connecting People to Save African Lives and Livelihoods".

Also the network was submitted by CIMMYT for the 2003 CG Partnership Award, presented at the CG AGM in Nairobi, Kenya, October 2003. Unfortunately the submission was not successful.

Soil Fert Net was the focus in the lead article (titled "Reducing the Footprint of Famine on African Soil") for the 2002-03 CIMMYT Annual Report.

The Future of Soil Fert Net

In the first few months of 2003 it became clear that Soil Fert Net would cease in its present form when the current grant concluded in December 2003. The Coordinators, other members and Rockefeller Foundation staff (John Lynam and Akinwumi Adesina) began to look at what next after Soil Fert Net. This process was conducted principally through a series of review, discussion and planning meetings and workshops that began in May/June and were held approximately one per month in August through November. They involved members of Soil Fert Net, CG centres, NGOs and the Rockefeller Foundation.

A Soil Fertility Consortium for Southern Africa

The concept of a Soil Fertility Consortium for Southern Africa was first discussed and agreed upon at a meeting on the Future of Soil Fert Net, held in Harare 9-11 June (see later in this report). A Steering Committee of 14 members representing Soil Fert Net CU, IARCs, NARS, and others held followup meetings to develop a full concept note for the Consortium.

It was agreed that the "Consortium for Soil Fertility Management and Policy Research to Enhance Food Security and Sustainability in Southern Africa" would cover a broader range of agroecologies or farming systems than the old Soil Fert Net, with work in semi-arid areas.

The goal of the consortium will be to contribute to increased food security and poverty reduction in order to enhance the livelihoods of resource poor households by promoting research and development in integrated soil fertility management in Southern Africa.
This would be achieved through:
- ⇨ Setting priorities for focused research on problems affecting resource poor farmers.
- ⇨ Promoting linkages among soil fertility management specialists at local, national and regional levels, with technical backstopping from the IARCs and ARIs.
- ⇨ Encouraging an inter-disciplinary team approach to understand and find solutions to complex problems of natural resource management.

- ⇨ Promoting a farmer participatory mode of research.
- ⇨ Enhancing the transfer of improved technologies to farmers through established institutional linkages.
- ⇨ Improving the skills and excellence among scientists, entrepreneurs and farmers.
- ⇨ Strengthen linkages between farmers and markets for soil fertility inputs and income from products.

The Consortium will concentrate initially on Zambia, Malawi, Mozambique and Zimbabwe. More partners and partnerships would be involved, including public soil fertility research and development institutions (DRSS, DARTS, AREX, INIA, universities, ACFD etc); IARCs (ICRISAT, CIMMYT, ICRAF, TSBF-CIAT, others); the private sector (fertilizer producers/ suppliers); NGOs, policy makers, and will be open to others as needs are identified.

The Consortium seeks to conduct and facilitate work initially in the following theme areas:
- ⇨ Characterization of soil fertility problems and identification of targeting domains
- ⇨ Biophysical process research
- ⇨ Technology adaptation and integration into farming systems
- ⇨ Scaling up, scaling out and strengthening linkages with markets
- ⇨ Fertilizer market development
- ⇨ Regional capacity building in soil fertility management and policy.

A simple, efficient and cost effective organizational and governance structure for the Consortium is proposed, to serve its diverse partners and member institutions and at the same time ensure that it maintains accountability and ownership to and by its members.

The components of the structure are: a Consortium Management Committee, a Scientific Working Group, a Coordination Unit (hosted by one of the CG Centers) and Country Teams/ Representatives.

Transition Proposal for 2004

A 12 Month Transition Proposal to develop and plan the Consortium was written at the request of the Rockefeller Foundation and submitted in December 2003. The transition phase will strive to secure buy-in from the wider stakeholder base, determine progress from previous work and decide on future priorities before progressing to develop work plans for the various themes identified during the planning phase.

For 2004, the transition proposal concentrates on the steps and support necessary to develop and begin to implement a broad Consortium to address priority soil fertility work in Malawi, Mozambique, Zambia and Zimbabwe in effective ways. To do this it proposes:

1. Several highly participatory and inclusive planning events and workshops to develop the Consortium, along with publicity leading to a launch in early 2005.
2. Additional characterization work will be undertaken to understand the extent of soil fertility problems, identify target agroecologies and farming systems, develop a framework for appropriate targeting of SFM (by agroecologies, farm niches, soil types and farmer groups) and identify consortium research work sites.
3. A series of critical synthesis studies to measure progress and draw lessons from previous soil fertility research and development initiatives in Southern Africa, including those that have been supported by the Rockefeller Foundation Food Security Program.

Synthesis Working Groups will cover:
- ⇨ Process and Adaptation Research on ISFM
- ⇨ Technology Transfer Methods and Experiences in Scaling up and Adoption
- ⇨ Economics, Markets and Policy.

Each involve a range of contributing individuals and organizations.

Consortium development will be guided by an Interim Management Committee and implemented through an Interim Coordination Unit (ICU). The ICU is proposed to be 4-person and part-time, involving 1 Zambian and 1 Zimbabwean, plus 2 CIMMYT staff, along with some targeted operating funds.

Integration and Partnerships

As the Soil Fert Net has been moving toward closure during 2003, in addition to the direct broadening of the network into a consortium as described above, the Coordinators have spent considerable time to help put in place a range of additional linkages and partnerships with other initiatives and projects. In this section we describe linkages with a new CIMMYT project on conservation agriculture and the African Conservation Tillage Network, the development of a Water Challenge project for the Limpopo Basin and links with the Africa Challenge Programme.

Conservation Agriculture

Soil Fert Net helped to organize and participated in a workshop in Harare from May 12-14, 2003 to discuss and define a project on "Conservation Agriculture for Eastern and Southern Africa". The project was submitted by CIMMYT to the German Federal Ministry for Cooperation and Economic Development (BMZ) for consideration under their targeted funding for the CGIAR Centers. The project has been funded and will begin mid 2004. Countries involved include Tanzania, Zambia, Mozambique, Malawi and Zimbabwe. Emphasis is on the promotion of conservation agriculture in maize-based farming systems through information provision and demonstration, training and widespread partnerships. Additionally, Soil Fert Net-CIMMYT was involved in the planning workshop for phase 2 of the African Conservation Tillage Network (ACT), which took place in Harare from 11 to 13 November.

Integration of Soil Fertility Work with Conservation Agriculture

There are many possibilities for closer integration of soil fertility and conservation agriculture. As with soil fertility benefits, many of the benefits from conservation tillage come in the medium term (three to six years) to long term. Soil Fert Net members need to supplement the few longer-term studies underway on research stations that have biophysical and management conditions similar to smallholder farms and set up some medium term experiments with farmers. There is a special need for longer-term experiments with ridging and hoe-mound systems in Malawi and eastern and northern Zambia to examine how best to manage soil fertility inputs (including N fertilizer, liming and green manures) without tillage and look at the benefits that accrue. This will include time taken for the breakdown of hoe pan barriers to root penetration into deep soil and the accrual of increased water and nutrient uptake and crop yield.

For important crop rotations and intercrops that farmers want to grow and that help soil fertility, e.g. pigeonpea-maize systems, we need to know more about the extent that conservation tillage systems improve soil fertility and cropping. These include effects on the amounts and fate of crop residues, maintenance of SOM, plough and hoe pans, rooting patterns, seasonal soil moisture dynamics, mineralization of nutrients and nutrient uptake by crops.

Combinations of conservation tillage, soil moisture conservation strategies and soil fertility inputs with drought tolerant and N use efficient maize may be especially productive and economic and may help farmers make investments into such systems. More widespread farmer testing of these systems needs to be encouraged by Soil Fert Net members.

Appropriate tillage for seasonal wetlands needs to be researched. This can help to exploit off-season cropping in dambos or vleis where water and nutrients concentrate, but where farmers may need to ridge to reduce waterlogging.

One of the major benefits from conservation tillage is less need for labour. Studies on the labour use and long term profitability of combined conservation agriculture practices is an important area of research for the EPWG. Soil Fert Net members may investigate the possibility of redeploying that labour onto producing more of certain labour demanding soil fertility inputs/ practices such as composting, growing of improved fallows, or using biomass transfer crops.

There is a great deal of overlap with the promotion of conservation tillage, water conservation and soil fertility practices. Crop residue management, organic matter replenishment, legume cover crops, fertilizer placement and use, reduced nutrient losses, crop rotations and intercrops, are all common elements. Soil Fert Net/ Consortium members can work very closely with the same farmers that are receiving conservation agriculture support. Farmers are proving slow to adopt some soil fertility technologies such as green manures, yet if they are also promoted as soil cover crops and as fodder for livestock, there may be more interest. By combining soil fertility technologies with soil and water conservation technologies, farmers may find them more attractive for adoption and they may be more inclined to invest into smallholder crop production.

Limpopo Basin Water Challenge Project

2003 saw the Coordinators and Soil Fert Net also involved in the development of a joint concept note and proposal for a project led by ICRISAT and CIMMYT for the Limpopo Basin. This was in response to a call for proposals by the CG Water and Food Challenge Program. Soil Fert Net Coordinators felt this would be an opportunity to develop additional funding on soil fertility technology promotion and market linkages for the semi-arid Limpopo.

The project proposal titled "*Increased food security and income in the Limpopo Basin through* *integrated crop, water and soil fertility options and public-private partnerships"* was submitted in September and has been accepted for core funding support from the Water and Food CP. It is hoped this 5-year project will begin mid 2004. The project will test the hypothesis that "Diversified crop, soil and water management options can be combined to reduce risks and improve productivity, profitability and sustainability of smallholder agriculture in the Limpopo, including the returns to scarce water supplies. Strengthened public and private partnerships to deliver seed, information and other inputs, and link farmers to product markets, will create incentives for farmers to adopt these technologies, and thus improve incomes and food security."

The project also involves Instituto Nacional de Investigação Agronomica (INIA), Mozambique, Limpopo Province Agricultural Strategic Team (LIMPAST), the Department of Agriculture, Limpopo Province, the Department of Agriculture, Mpumalanga Province, University of Venda, South Africa, the Agricultural Research Council and Agricultural Research and Extension (AREX), Zimbabwe.

Sub-Saharan Africa Challenge Programme (SSA-CP)

In a further attempt to link more widely, Soil Fert Net sponsored Danisile Hikwa of AREX Zimbabwe and Renneth Mano from the University of Zimbabwe to represent the network at the SSA-CP Programme Formulation Workshop on "Improving Livelihoods and Natural Resources Management in Sub-Saharan Africa: Securing the Future for Africa's Children", held in Accra, Ghana from 10 to 13 March 2003. The Coordinators felt that the experiences and organizational model of Soil Fert Net would be helpful for the SSA-CP to consider when developing its programme.

Additionally, the Soil Fert Net Coordinators were able to input into the planning for the Formulation Workshop by responding to requests to complete questionnaires and develop a position paper about CIMMYT in relation to the SSA-CP that included soil fertility and capacity building as important elements of our strategy. CIMMYT was represented at the meeting by other staff. We hope the SSA-CP will move forward to support some work related to natural resource management, including soil fertility, in southern Africa. Soil Fert Net and the Soil Fert Consortium look forward to being involved.

Network Research

Soil Fert Net was able to provide additional top-up grants to members during 2003 to support work in Zambia, Malawi and Mozambique that had begun in 2001 or 2002. Nevertheless, in general the level of funding support from within Soil Fert Net, that from other grants by the Rockefeller Foundation and apparently from other donors all fell to critically low levels. A great deal of donor support and interest from NGOs and government agencies moved away from soil fertility research and promotion issues to the more immediate concerns of feeding people in several countries in the region after recent droughts and other constraints (that include the consequences of unaddressed soil infertility). In the annual report this year, we cover latest developments with the on farm soil fertility research programmes in Mozambique and Zambia, examine maize responses to sulphur (S) in Malawi and report recent findings about the performance of abiotic stress tolerant maize subjected to weed competition and low N rates near to Harare, Zimbabwe.

Soil Fertility Research with INIA in Mozambique (Candida Cuembelo, Paulo Chaguala and Laurinda Nobela, INIA)

INIA (the national agricultural research institute of Mozambique) and Soil Fert Net/CIMMYT conducted a set of on farm grain legume-maize-cassava rotation experiments that began in 2002-03. Soil Fert Net provided start up-top up funding for all of this work, participated in the development and the implementation of the surveys (reported below) and experiments, as well as in follow up meetings. Background planning for the work was described in the Soil Fert Net Annual Report for 2002.

Soil infertility is a major constraint in Mozambique: Findings of farmers survey — A two stage farmer survey to understand farmers' soil fertility and maize production constraints was undertaken in the central and southern provinces of Mozambique. The first stage of this work, completed in February 2003, involved an informal survey of about 120 farmers. The second stage, in March and April 2003, involved a formal questionnaire survey of 452 farmers in Manica and Inhambane provinces.

The study had the following specific objectives:

⇒ Describe farmers' current soil fertility management and maize germplasm use and develop baseline data for maize production in the study areas

- ⇨ Elicit farmers' perceptions, preferences and assessment of existing and new soil fertility management technologies and maize germplasm
- ⇨ Determine and quantify the pattern and intensities of adoption of maize production technologies
- ⇨ Identify the relative importance of factors influencing adoption of maize production technologies
- ⇨ Generate recommendations for research, extension and policy makers to enhance technology adoption and dissemination.

Socio-economic description of farmers. The survey results indicate that most households, over 64% and 82% in Inhambane and Manica provinces, derive their livelihoods from agricultural activities. There are very few opportunities for off-farm income. The annual household incomes averaged US235 and US239 in Inhambane and Manica respectively. Most of the cash income is earned from sale of farm produce. In Inhambane, sale of fruits was very prominent. Most farmers are poor with a very thin asset base. Very few (<15%) own cattle, and for these few the average herd size was less than five beasts per household. Farmers said they lost most of their livestock during the civil war. In all the communities visited, there were generally high levels of illiteracy among adults. Access to land is not a problem, with the land holding averaging about four ha per household. Farmers have difficulty accessing the distant input and output markets because of poor roads and high transport costs. Extension facilities are present but fail to adequately cover the farmers because of limited resources. Only 7% and 18% of the farmers in Inhambane and Manica Provinces respectively, reported contact with extension officers. Credit facilities were not easily available to farmers. Only 4% and 19% in Inhambane and Manica were able to get credit in the 2002 season, mostly provided by NGOs active in the areas.

Farming systems and crop production. The farming systems in the two provinces are maize based. However, maize is less prominent in Inhambane, especially in the coastal areas where farmers grow many fruits. Cassava, sorghum and millet are also important food crops grown by farmers. There is very little animal production in the two provinces.

Maize, cassava, sorghum and millet were the most important food crops grown by farmers. In Manica, maize predominates, while in Inhambane cassava is equally important. The maize area per farm ranged from 0.5 ha to over 4 ha depending on the farmer's resource base. In Inhambane, there are two maize seasons. The main season is in summer from September to April and the minor (cooler) season is from March to July. In the cooler season, residual moisture and some light showers, which usually occur near the coast, make maize production possible. In Manica, maize is mainly grown during the summer season. However, some farmers have access to wetlands and can grow maize throughout the year.

Farmers' soil fertility management practices. Farmers were able to identify and characterize the soil types found in their communities. These soils have different soil fertility status and are used for different cropping systems. Soils found in Inhambane are mostly sandy, low in fertility and not very suitable for maize production. In Manica, the soils are heavier. The most commonly occurring soil type, chika, is the most fertile and is suitable for maize production.

Farmers identified low soil fertility as one of the major constraints to maize and production of other crops. Many farmers have difficulties to manage soil fertility because of their poor asset base. Most farmers cannot afford inorganic fertilizers; only 2% in Inhambane and Manica used inorganic fertilizers in 2002. Most have no access to animal manure because of lack of cattle and cannot incorporate the stover and grass material into their fields because they have no access to traction power or do not own the necessary implements such as a plough.

Table 2 shows farmers' use and knowledge of the various options of soil management technologies. Fallowing, leaf litter and avoiding burning of fields, were the most common means of managing soil fertility practiced by 60% or more of the survey farmers in both provinces. Cattle manure and crop rotations were the next important soil fertility management practices in both provinces. The use of cattle manure was higher in Manica (19%) than in Inhambane (13%) while there was more use of crop rotations in Inhambane (44%) than in Manica (22%). Use of inorganic fertilizers, green manures, anthill soil and compost was negligible (9% at most), and virtually none for lime in both provinces.

There were very close correlations between farmers' awareness/adequate knowledge of a soil fertility management technology and their use

Table 2. Farmers' soil fertility management practices in Inhambane and Manica provinces, Mozambique

	Percentage of farmers			
	Inhambane		Manica	
	Currently use	Have knowledge	Currently use	Have knowledge
Inorganic fertilizer	2	25	2	20
Rotation	44	51	22	27
Cattle manure	13	56	19	41
Lime	0	1	0	1
Green manure	3	6	5	9
Ant hill soil	8	7	9	11
Compost	3	13	1	8
Leaf litter	62	74	45	48
Avoid burning field	65	74	72	73
Fallowing	84	87	62	68

of the technology except in the case of cattle manure and inorganic fertilizer. The proportion of farmers who used a technology was roughly in line with those who said they were aware or had adequate knowledge of the technology. However, in the case of inorganic fertilizers and cattle manure, the proportion of farmers who used these technologies was much smaller than those who were aware or had adequate knowledge of these two technologies. For example, while 85% said they were aware of cattle manure, only 13% of the survey farmers used cattle manure in Inhambane. Similarly, while only 2% of farmers in Manica used inorganic fertilizers, about 64% said they were aware of them. What can be derived from this is that use of green manure, ant-hill soil, compost litter, fallowing and avoiding burning of field were related to farmers' awareness and knowledge of these technologies. While for fertilizer and cattle manure, availability and affordability were important in determining their use by farmers.

It is well known that the effectiveness and subsequent benefits of a technology depend on its intensity of use rather than the incidence or pattern of adoption. In the study areas the quantity of inorganic fertilizer applied per ha by the few survey farmers was lower in Inhambane (only 18 kg/ha) than in Manica (77 kg/ha). In both provinces the amount used has not changed in the two seasons they have used it. Cattle manure was an older soil fertility technology to the survey farmers than inorganic fertilizer. Recently the amount of cattle manure applied per ha in both provinces has declined when compared to the amount used when farmers started using it. For example, while on average about 473 kg/ha of cattle manure was applied in the 1990s in Manica, about half of this, 273 kg/ha, was applied in recent years (2002) due to the decline in number of cattle owned by farmers.

In summary, (1) inorganic fertilizer was a recent technology to farmers and the adoption rates were very low and (2) fallowing and incorporation of grass material were the two dominant methods used by the survey farmers to manage soil fertility in both provinces. The sustainability of these two soil fertility technologies is doubtful given the likely increase in population and intensification of production. In the longer run, fallowing would be difficult to practice for farmers as land becomes scarce. And incorporation of grass material will not provide adequate fertility to sustain high maize yields.

Most of the survey farmers perceived that the benefits of most of the soil fertility management technologies were worthwhile. This calls for a coordinated effort for the extension service and NGOs to promote the relatively new soil fertility management practices in the study areas. Policy interventions to improve access to inorganic fertilizers and cattle manure are required.

Constraints to maize production. Farmers' maize yields are very low, averaging less that 1t/ha. Farmers cited several natural and socio-economic factors, whose interplay results in reduced maize yields in the communities visited. Farmers produced very interesting but similar causal diagrams for low maize yields observed in their fields. One of the typical scored causal diagrams produced by farmers for low maize yields in Manica Province is in Figure 2.

Farmers cited drought, low soil fertility, striga, weeds, maize diseases and termites as the direct causes of low maize yields. Drought was rated the most important constraint. Soil fertility is the next major problem. Many farmers do not own or have access to cattle so they are forced to burn the organic material in their fields when preparing land. Farmers explained that their burning of organic matter leads to poor soil fertility. Furthermore, farmers do not have adequate cash to buy inorganic fertilizers. They complained that the output markets are fragmented and the few buyers who come to them offer very low prices for their produce. Market development is therefore key and should be an integral strategy for improving farmer's livelihoods.

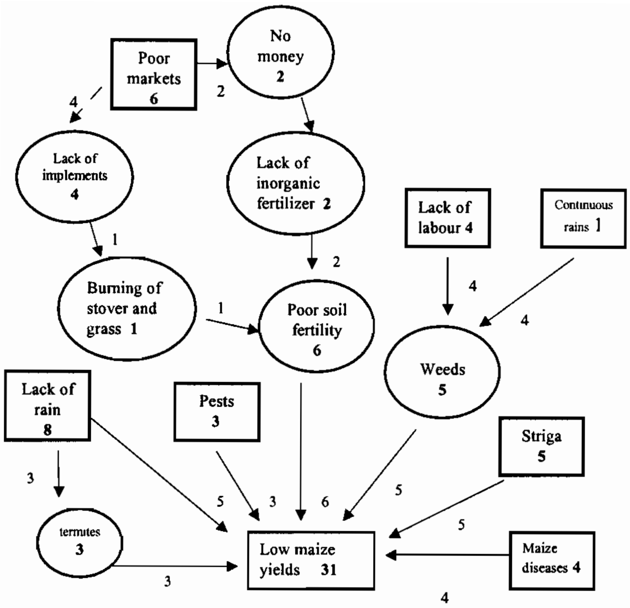

Figure 2. Scored Causal Diagram for maize production, Sussundenga, Manica, Mozambique

On-Farm Rotation Experiments — On farm pigeonpea/cowpea-maize-cassava rotation experiments were planned for the 2002-03 season in Manica and Inhambane Provinces (see the 2002 Annual Report). Twenty-five on farm experiments were expected to be established by extension staff with farmers in Inharrime district of Inhambane Province. All were planted and maize was harvested from eight sites. Drought and other factors killed the maize at other sites. The extension service is far more established in Manica Province, and this led researchers to plan to plant 150 on farm experiments throughout Manica Province. Of these, 47 were planted (22 in Manica, 8 in Sussundenga, 6 in Tambara, 5 in Gondola, 4 in Macossa and 2 in Mossurize districts) and maize was harvested from almost all. Reasons for the shortfall included late availability of the legume seed for season one of the rotation, severe drought around planting time in Manica province, and staff shortages coupled with an overcrowded planting agenda for extension staff charged with implementing the experiment. Maize grain yields without fertilizer from these experiments were in the 600-1000 kg/ha range. Responses to 60 kg/ha N and 30 kg/ha P_2O_5 were very variable, with good responses at some sites with good moisture. The second year (2003-04 crop season) of the experiment involves maize in the rotation plots. Some additional sites of the trial are being established in 2003-04.

Review Meetings and Training — The Coordinators of Soil Fert Net visited INIA in Maputo, Mozambique 13-15 August, 2003, along with Michael Morris, Director of the CIMMYT Economics Program from Mexico; and Augustine Langyintuo, Agricultural Economist CIMMYT Zimbabwe, to review the experimental and survey results and plan their future, and explore how to strengthen INIA's economics research work. Related discussions covered the new CIMMYT / Rockefeller Project on *Strengthening Seed Markets to Improve the Impact of Maize Breeding Research in Southern Africa* and seek INIA's input to the Water and Food Challenge Program being developed by ICRISAT and CIMMYT. The visiting team interacted with the Director, Dr Calisto Bias, and his team of senior researchers, along with a visit to the Faculty of Agriculture of the University of Eduardo Mondlane.

Plans were made to continue the pigeonpea/cowpea-maize-cassava rotation on-farm experiments planted in Manica and Inhambane last season, add some of the extra sites that could not be planted last year due to the drought, and ensure that inputs are delivered early to INIA and extension field staff conducting the experiments.

Shephard Siziba followed up the first week of September to work with and train INIA staff to analyze some of the data from the formal soil fertility and maize production surveys that were conducted after the informal surveys in Manica and Inhambane provinces.

Maize Response to Sulphur Fertilizer in Lilongwe ADD, Malawi (Allan Chilimba, Vernon Kabambe and IMD Chirwa, DARTS)

Field experiments were conducted to assess the performance of two sources of sulphur – ammonium sulphate and gypsum – in maize production. The experiments were conducted at six sites in Lilongwe Agricultural Development Division (ADD) in central Malawi. Our previous soil survey work has shown widespread deficiencies of soil S in Lilongwe ADD (see ADC Chilimba et al. Soil Fert Net Research Results Working Paper 11, 2002).

The Field Experiments — The two sources of sulphur –sulphate of ammonia and gypsum– were applied at five rates; zero, 10, 20, 40 and 60 kg S per hectare. The experiment was implemented at Mlomba, Chafumbwa, Demela, Bembeke (2 sites), Kanyama, Mayani, Manjawira, and Tsangano Extension Planning Areas and at Chitedze Research Station. However, three experiments were lost. The trial at Mayani was washed away by floods and two experiments at Demela and Chafumbwa were harvested by farmers before the yields could be measured.

The experiment was laid out in a randomised complete block design with three replicates. Two external controls that represented the two current S fertilizer recommendations (4 and 8 kg S/ha/year) for maize in Malawi, were used. N fertilizer was applied to maize at standard recommendations.

Maize Response to Sulphur Application — Table 3 summarizes the maize grain yields after sulphur application at the harvested sites. Sulphur application significantly increased maize grain yields at all the sites. At Chitedze station there was no significant difference between the two sources of sulphur in grain yields. There, sulphur application significantly increased maize grain yields with the highest yields at 20 kg S/ha (Table 3). At Bembeke the sources of sulphur and rates of sulphur application gave significantly different grain yields. Gypsum out-yielded ammonium sulphate and again 20 kg S/ha gave the higher grain yield. Gypsum contains calcium, which might have helped improve maize yields at Bembeke where the soils are strongly acid. Although neutral in its reaction, it supplied calcium to the maize crop. At Bembeke we observed that the roots in gypsum-applied treatments were bigger than those from ammonium sulphate plots.

Table 3. Maize grain yield (kg/ha) as affected by rates of sulphur application at six sites in Lilongwe ADD, Malawi 2002-03

S Rates	Chitedze	Bembeke	Mlomba	Tsangano	Manjawira	Kanyama
0 (kg/ha)	5998	6181	2564	4629	2674	4509
4	6868	6410	2662	3479	-	4899
8	7417	7486	3388	4899	2335	5906
10	7623	10006	3319	7514	3593	5243
20	8218	11771	3616	6712	4341	5723
40	8149	10503	3182	8240	3451	5357
60	7600	11540	3777	9623	4539	6661
SE (Rate) =	363	587	224	243	341	312
CV% =	19.49	19.40	23.7	21.03	38.5	21.4

There were no significant differences between sources of sulphur in grain yields at Mlomba, Tsangano, Manjawira and Kanyama. Both sources were equally effective in supplying sulphur to the maize crop. At Mlomba the optimum sulphur application was 10 kg S/ha, 40 kg S/ha at Tsangano, and 20 kg S/ha at Manjawira and Kanyama (Table 3). When the current recommended sulphur application rates were compared with the higher experimental rates, the experimental rates of sulphur significantly increased grain yield at all sites except at Mlomba where 8 kg S/ha was equally effective in increasing grain yields (Table 3). The low response to sulphur at Mlomba can be explained by a higher soil sulphur level at Mlomba, which is close to the critical sulphur level. However, at Chitedze, the soil sulphur level was above the critical level but the maize still responded to higher rates of sulphur application.

Conclusions — There is a strong indication that the current 4 to 8 kg S/ha recommendation is inadequate for optimum maize production at most sites in Lilongwe ADD. This could be a national problem since soils, cropping patterns and recent history of fertilizer use are similar elsewhere. It is likely that sulphur deficiency is limiting maize production in large parts of Malawi. There is a need to extend the studies nationwide. We hope to extend the studies to cover the most important maize growing areas in central, southern and northern Malawi during 2003-04 and to test elemental sulphur.

Maize Germplasm Studies in Sub-humid Zimbabwe (Stephen Waddington and Johannes Karigwindi, CIMMYT)

We have conducted field experiments to assess the performance of several SADLF-CIMMYT drought tolerant or N use efficient hybrids and OPVs over a range of N fertilizer rates and with weeds. We have also examined the performance of an ACFD dwarf maize hybrid when intercropped with sugar bean.

N Fertilizer Response of Hybrids and OPVs — The SADLF project has developed 'nitrogen use efficient' (NUE) maize genotypes, selected under both managed nitrogen stress and nitrogen optimum conditions. An experiment was conducted to test the response of four NUE genotypes (two hybrids and two open pollinated varieties (OPVs)) and a commercially available hybrid (SC513) to several rates of N fertilizer. The experiment was conducted on a sandy loam soil at the Agricultural Research and Extension (AREX) training centre farm at Domboshava, near to Harare, in 2000-01 and 2002-03.

Five maize genotypes — two experimental CIMMYT OPVs (ZM421 and ZM521), two experimental CIMMYT hybrids (CML395/CML312//CML440 and CML395/CML444// CML440), and a commercial three-way cross hybrid control (SC513) — were tested. The genotypes were fertilized at 0, 15, 30, 60 and 90 kg N ha^{-1}, using ammonium nitrate. The entire N in the 15 and 30 kg N ha^{-1} treatments was applied at planting, as was 30 kg N ha^{-1} of the other N rates. The remaining N was applied when the crop was approximately waist height. A uniform basal application of 60 kg P_2O_5 ha^{-1} (as single super phosphate) and 30 kg K_2O ha^{-1} (as muriate of potash) was applied at planting. The 2000-01 season at Domboshava had excessive rainfall (1081 mm). Rainfall in 2002-03 was moderate (711 mm) and well distributed.

Figure 3 shows the performance by maize germplasm type for two seasons at Domboshava. The experimental genotypes out-yielded SC513 with zero or 15 kg N ha^{-1} in both seasons. Experimental OPVs gave 229 kg ha^{-1} (26%) more grain yield than SC513 at low N (averaged over zero and 15 kg N ha^{-1} applied) in 2000-01 and 516 kg ha^{-1} (21%) in 2002-03. The corresponding values for the experimental hybrids were 435 kg ha^{-1} (50%) in 2000-01 and 604 kg ha^{-1} (24%) in 2002-03 (Figure 3).

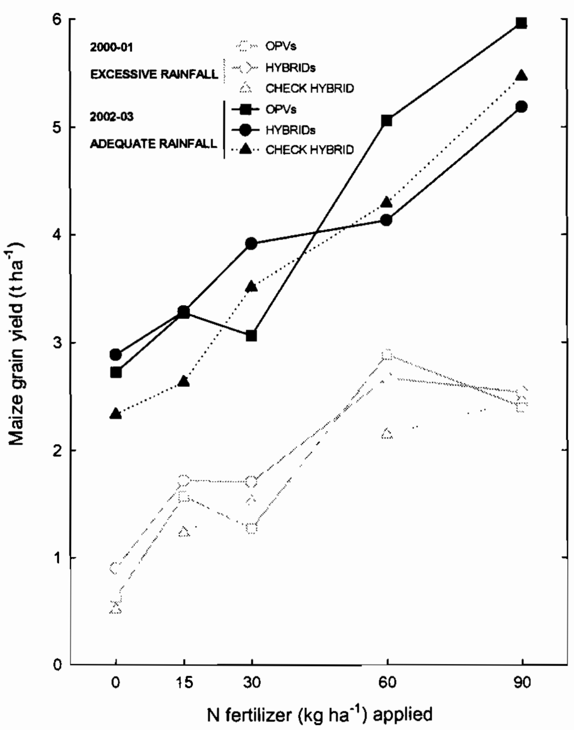

Figure 3. Maize grain yield (t ha^{-1}) of experimental N use efficient maize OPVs and hybrids across five N rates at Domboshava, Zimbabwe in 2000-01 and 2002-03

These results provide some evidence that the experimental genotypes can give more grain yield with very small amounts of N fertilizer, a trait that will be very useful to provide more food and cash for the many smallholder farming situations where little or no fertilizer is applied. Additionally, the similar responsiveness of the OPVs and the hybrids to N fertilizer suggests that farmers who are able to apply N fertilizer may be better off investing in the cheaper seed of new OPVs than in hybrids. A cost-benefit analysis is needed.

Weed Tolerance of Hybrids — Several CIMMYT-Zimbabwe maize materials have already been identified to perform moderately better under weed competition than others (Waddington and Karigwindi, 1996). This may also be the case with drought tolerant/NUE SADLF-CIMMYT maize types. Weeds augment drought stress by competing with crops for limited moisture. Secondly, weeds reduce the NUE of crops by competing for essential mineral nutrients. An experiment to test the performance of these SADLF-CIMMYT hybrids after competition from weeds was carried out in 2002-03 at Domboshava.

Three commercial hybrids (SC515, PHB30G97 and AC31 dwarf) and three SADLF-CIMMYT hybrids (CML312/CML395//CML440, CML444/CML395//CML440 and CML202/CML395//CML197/CML312) were clean weeded (W1) or grown under natural amounts of weed competition up to six weeks after crop emergence (W2), with either a low rate of 30 kg N ha^{-1} (N1) or a high rate of 90 kg N ha^{-1} fertilizer (N2).

In Figures 4 and 5, weed and fertilizer treatments are arranged in order of increasing stress (W1N2, W1N1, W2N2 and W2N1). The results showed that at Domboshava, all the weed-free plots produced a mean maize grain yield of 6.7 t ha^{-1} and the plots under weeds produced a mean maize grain yield of 4.9 t ha^{-1}. With high stress (weeds and low N fertilizer), all three SADLF genotypes out-yielded (weeds x genotype interaction, $P > 0.07$) the three commercial hybrids by 1.9 t ha^{-1} (42%). These are large effects.

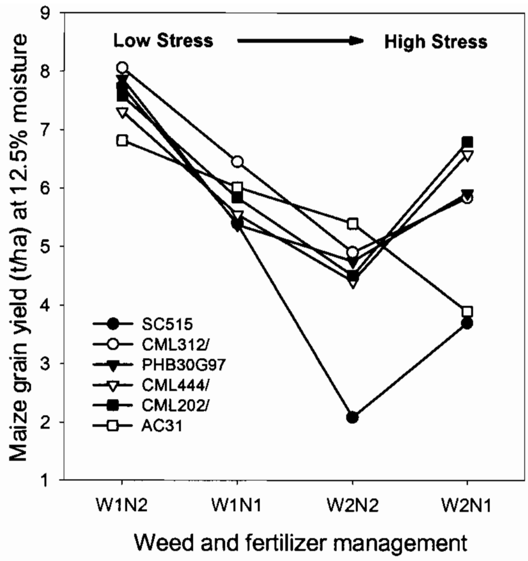

Figure 4. Grain yield of six maize genotypes grown with weeds and N fertilizer at Domboshava, 2002-03

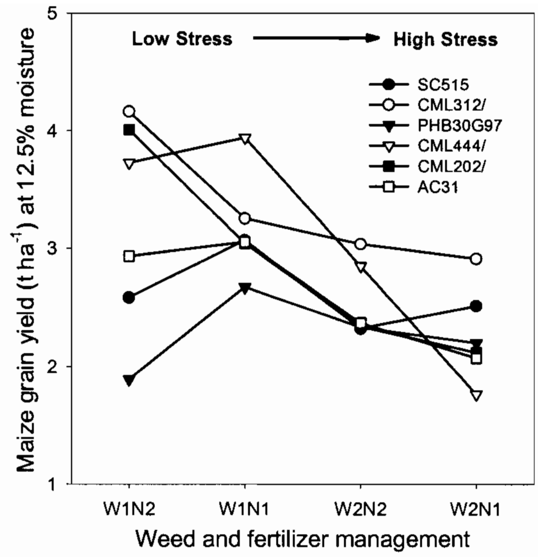

Figure 5. Grain yield of six maize genotypes grown with weeds and N fertilizer at CIMMYT Harare station, Zimbabwe, 2002-03

Our results suggest that the SADLF-CIMMYT hybrids have some traits that enable them to better tolerate weedy and low N conditions. Evidence is building that they can be expected to perform somewhat better than existing maize hybrids when grown under mixed water, N and weed stress.

Waddington, S. R. and J. Karigwindi, 1996. Grain yield of maize populations and commercial hybrids after competition from weeds early in crop development. *Zimbabwe Journal of Agricultural Research* 34: 45-54.

Legume Intercrop with Dwarf Maize — Suggestions have been made that dwarf maize may be more suited to intercropping than conventional height plant types, allowing higher yields from an under-storey grain legume crop. To test this, the ACFD dwarf maize hybrid, AC31, was compared with the commercially available standard height hybrid SC513, when grown as a sole crop or intercropped on the same row with sugar bean. The experiment was conducted at Domboshava station, near to Harare, in 2002-03. Plots were kept weed free and fertilizer was applied to the maize at 92:17:16 kg NPK ha^{-1}.

Grain yields from AC31 dwarf maize were similar in the intercrop and sole crop, but were only around 73% (2.33 vs. 3.20 t ha^{-1}) of those from SC513. However, a 25.6% higher bean grain yield (an additional 118 kg ha^{-1}) and 17.3% larger haulm yield were achieved under a canopy of AC31 plants than with SC513 (Figure 6).

This suggests that AC31 may be attractive to farmers that are interested to produce a closer balance of bean and maize grain from intercropping than is possible with conventional large leaf area index maize hybrids.

Managing Soil Fertility Decline in Zambia
(Moses Mwale, DRSS)

The Department of Research and Specialist Services of Zambia received US$8,000 from the Soil Fert Net as top up funds for the season 2002/03. This money was used to complement funding

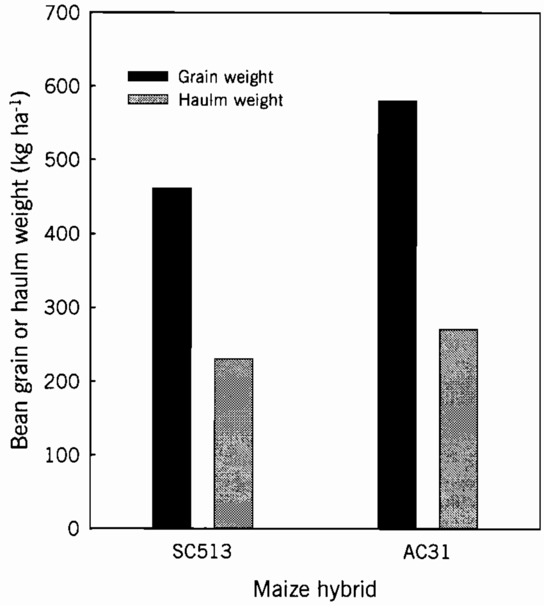

Figure 6. Sugar bean grain and haulm yields (kg ha^{-1}) from bean intercropped with a dwarf (AC31) or a normal height (SC513) maize hybrid at Domboshava, Zimbabwe, 2002-03

from the government in carrying out soil fertility research in the country. The work being carried out in Zambia aims to formulate strategies through a multifaceted approach to cover a wide range of soil fertility related production problems.

Green manure and grain legume experiments were continued in Southern Province (Kalomo, Choma and Sinazongwe), in Central Province (Kabwe and Muswishi), and in Northern Province (Kasama, Mungwi and Mbala). The species used in Southern and Central Provinces were velvet bean, sunnhemp, cowpea and pigeon pea. In Northern Province, *Tithonia diversifolia*, bean and soyabean were added. Experiences from past work indicate that farmers complain about incorporating green manures due to labour demands at peak periods. To alleviate this problem, the plots were large enough (20m x 20m) to allow half (20m x 10m) of the crop to be incorporated and half to be left on the soil surface. This will allow for comparison of the two methods. In the coming (2003-04) season, maize will be grown with varying rates of nitrogen (at zero, quarter, half and full rate). The full rate of nitrogen recommended in most Zambian soils is 112 kg N ha^{-1}. The maize from the green manure trials grown last season has just been harvested and is being analyzed. Results will be reported later.

More *Tephrosia vogelii, Sesbania sesban* and *Gliricidia sepium* demonstrations were established in Southern Province during 2003, in addition to those established last year. Unfortunately, *Gliricidia sepium* seedlings didn't grow well due to a dry spell experienced immediately after planting. To avoid these tree species being damaged in the dry season when animals are left to graze freely, a live fence with *Jatropha cacus* was put up around the demonstrations. Further, fireguards have been put up around the same plots to avoid damage from fires that are common in the area during the dry season.

Unavailability of seed is always a problem in the use of either multipurpose tree species or green manures. A deliberate effort is being made so that wherever these experiments and demonstrations are placed, seed production for these species is emphasized.

Isolation and maintenance of the rhizobium strains in the laboratories at Misamfu and Mt. Makulu was continued. Rhizobium strains for *Gliricidia sepium, Tephrosia vogelii, Sesbania sesban, Glycine max and Phaseolus vulgaris* were maintained. The other activity was the production of inoculants for trees that were raised in the nurseries. There is now a steady demand for these tree seedlings by farmers.

Work in pit farming was also continued. Three-year pits had better maize yields (3 t ha^{-1}) than second year (1.6 t ha^{-1}) and first year pits (0.8 t ha^{-1}). The explanation for this could be that as decomposition of the materials (grasses, legumes, crop residues, etc) continued, more nutrients were available for plant uptake. The number of farmers practicing pit farming has steadily increased.

An experiment was conducted with the aim of focusing on a practical application of Ground Phosphate Rock (GPR) combined with vegetative organic materials to serve as a source of phosphate nutrition for crops in identified farming systems. The test crop was bean in this greenhouse experiment. Results showed that 60 kg P_2O_5 ha^{-1} was appropriate in quickening the decomposition of the organic matter (Figure 7).

Economics of Best Bets: Policy and Institutional Support to Enhance Adoption and Promotion (Mulugetta Mekuria and Shephard Siziba)

Financial Analysis, Risk Analysis and Adoption of Soil Fertility Management Technologies (SFMTs) — Several studies have been conducted by Soil Fert Net's Economics and Policy Working Group (EPWG) in Malawi (by Phiri), Zimbabwe (Gatsi et al., Mano and Rugube), Zambia and Mozambique (Mekuria and Siziba) to understand the profitability, adoption benefits, constraints and challenges that farmers face. Financial analysis of *Mucuna* green manure-maize rotations in Zimbabwe and Malawi (Mekuria and Siziba) revealed that pay-offs to investing in *Mucuna* as a green manure in both Zimbabwe and Malawi were positive but small for both

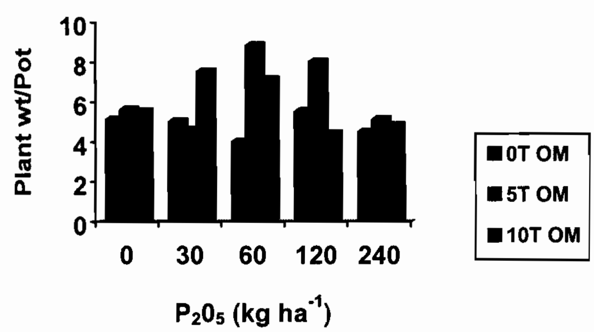

Figure 7. Effect of organic matter on phosphate rock decomposition in Zambia

land constrained and land adequate smallholder farmers.

Table 4. Partial budgets of soil fertility technologies compared to farmers fertilization practice (69:21:0:4S) in Malawi-US$/ha (from Chilongo, 2003)

	Soil fertility cropping pattern				
	Mucuna-maize rotation	Groundnut -maize rotation	Pigeonpea/ maize intercrop	Tephrosia/ maize undersowing	Soyabean -maize rotation
Yield increase of maize (kg/ha)	1580	1190	655	-65	985
Yield of intercrops (kg/ha)			1059		
Yield of rotated crop (kg/ha)	2073	4215			1170
Total benefits (US$/ha)	606.45	4160.70	964.70	86.60	1116.80
Total costs (US$/ha)	508.23	623.95	79.63	125.93	543.71
Net benefits (US$/ha)	98.22	3536.75	885.07	-39.33	573.09
Marginal Rate of Return (%)	19	567	1112	-31	105

However, farmers do not only consider profitability of SFMTs but also aim to minimize risk and want to maintain a certain level of household food security. Although returns to mucuna were found to be favorable, it also can expose farmers to some considerable risk. After formalizing risk, the probabilities of negative returns were calculated to be 30% in Zimbabwe and 38% in Malawi. Such a risk is quite substantial for the land-constrained farmers who have to forgo one season of maize harvest to grow mucuna (Mekuria and Siziba).

In Zimbabwe, SFMTs offer significant yield gains, but when combined with current farm management practices and current pricing policies the impact on income is very limited – except for soyabean (Mano and Rugube). Chilongo in Malawi used a Policy Analysis Matrix to compute the private and social profitability of several SFMT options (Table 4). It indicated that all the soil fertility technologies, except for undersown *Tephrosia*, did help build the fertility status of the soil better than modest rates of mineral fertilizer (69:21:0:4S), a current farmer practice. *Mucuna* fed the soil the best and gave the highest maize grain yield increase (of about 1.5 t/ha), but groundnut and pigeonpea had the highest net returns because they produced higher value and more marketable legume grains than did other legume grains. *Mucuna* had relatively poor net returns (US$19/ha), because currently the grain is of little economic importance to farmers. Chilongo showed that groundnut-maize rotations, pigeonpea/maize intercrop and soyabean-maize rotations are likely to be adopted (with marginal rates of return (MRR) of at least 100%). Though *Mucuna* had positive returns, it is unlikely to be taken up by farmers because of a low MRR. *Tephrosia,* with negative returns, is very unlikely to be adopted. Table 5 shows highly variable use and use intensity for a range of SFMTs in northern Zimbabwe.

Table 5. Farmer awareness, frequency and intensity of adoption of a range of soil fertility management technologies (SFMT) in northern Zimbabwe, 2001-2002. (from Mano and Rugube, 2003)

	Aware	Willing to use	Using	Rate of application (kg/ha)	Recommended rate (kg/ha)	% arable area under technology
	Percent of farmers					
Fertilizer	99	90	97	193	400	65
Cattle manure	98	93	86	1224	6000	20
Lime	81	74	13	18	300 per yr	6
Soybean rotation	85	93	58	-	-	-
Green manure	51	88	35	3% of maize area	50% of maize area	6
Termite mound	94	65	45	-	-	-

These studies revealed that despite many SFMT options for farmers, and efforts to popularize and promote them, their use and adoption has been very slow and their future is uncertain. These studies have identified that lack of appropriate information about technologies, their often modest potential financial returns, lack of input availability and affordability, no access to credit and output marketing, are factors that constrain adoption of SFMTs. Farmers need to make a significant initial investment in knowledge, land, capital or labour. The existence of a time lag before the farmer starts to obtain benefits from legume options, and often more complex management requirements, have been identified to be additional critical factors in the adoption process. Private profitability of introducing legumes into the system was found to depend on the opportunity cost of land and family labour.

A synthesis of SFMT adoption studies by EPWG-Zimbabwe (Mano) confirmed that the likelihood of adoption is influenced by type of technology, farmer specific socioeconomic characteristics and crosscutting economic policies and institutional parameters. For mineral fertilizers and cattle manure, households with more land, more wealth and those with more experience (and for manure older) than average, higher rainfall and farm size were important determinants of adoption. In the case of lime use, households with more land and more wealth, active membership in an extension group and high rainfall are more likely to adopt.

Linkage with Policy — Soil Fert Net /EPWG studies highlighted the important roles of institutional and policy support to enhance adoption and scaling up of best bet technologies in southern Africa. Economic reforms introduced since the early 1990s have not favoured small farm agriculture in general as market imperfections still persist within regional economies. The rate of liberalization of input markets was much faster than that of output markets, especially that of maize. Maize has been re-controlled in some countries. The changing policy framework in grain marketing in Zambia and Zimbabwe has created uncertainty and a vacuum in the delivery of inputs and output marketing. The low producer pricing policies adopted by governments heavily tax smallholders while subsidizing urban consumers. Mano and Rugube (2003) reported that in the last two years, the maize producer price in Zimbabwe has been 30% of the import parity price. Farmers have reported that the low producer prices they receive discourage them from investing in soil fertility management technologies, contributing to low yields, reduced maize production and to national food insecurity.

Studies conducted by EPWG grantees in Zimbabwe and Malawi have confirmed that limited and /or absence of market outlets selling required seeds for green manures and grain legumes are major factors explaining the slow adoption rates. The studies also identified that marketing services linking farmers to markets, distance to input and output market are major institutional constraints that require the attention of policy makers. New market innovations that are likely to reduce transaction costs and increase farm level returns to the adoption of the technologies are being examined in the region. Pilot studies in Zimbabwe and Malawi demonstrated the potential role of trained rural agro dealers in bringing inputs and information nearer to farmers and making them available in small packages. Alternative output marketing arrangements that would reduce marketing costs and encourage the adoption of best bets are also being tested.

Findings from EPWG studies need to be urgently communicated to policy makers. Identification of technology-specific policy support and advocacy strategies required for improving soil fertility have been limited. Under the new regional Soil Fertility Consortium, members plan to produce policy briefs that document these lessons, and identify the policy implications and policy instruments required to enhance the adoption and promotion of SFMTs.

Networking and Information Exchange

Mini Field Tour in Central Malawi

(Amon Kabuli, Malawi and Luckson Phiri, Zambia)

This mini Malawi tour was organized by Soil Fert Net and the Risk Management Project and took place from 9 to 13 March 2003. The tour was scheduled to cover various aspects of legume research and *Striga* soil fertility interactions, sulphur studies, risk management project activities and was planned to link up part of the time with a tour organized for the United Nations Millennium Hunger Task Force (UNMHTF), by ICRAF.

The tour proved to be a worthwhile event that made participants aware of the various technologies available to farmers to improve their soil fertility and increase maize yields at very low costs of production. About 18 participants joined the tour. They came from CIMMYT–Zimbabwe/Soil Fert Net, Zambia's Department of Research and Specialist Services (DR&SS), CIMMYT–Malawi/Risk Project, Department of Research and Technical Services (DARTS), Extension service, Concern Universal, Bunda College of Agriculture and CARE International in Malawi.

The tour began by visits to on-station legume research at Chitedze Research Station. Webster Sakala showed visitors some long–term experiments with maize and pigeonpea rotation and intercrop interactions. These trials have been carried out for an eight-year period now and the impression was that maize responded well to the pigeon pea residues that were incorporated at the end of the rotation. Maize intercropped with pigeon pea was observed to perform much better than the maize that was either in rotation with pigeon pea or was in a continuous maize stand.

The main message from this was that yearly incorporation of maize residues alone would not improve maize yield; as such farmers should be advised to follow either an intercrop or a rotation with pigeon pea in order to increase their maize yield. Such a maize-legume system was reported to produce up to 2 t of maize per hectare, which is enough to feed a family for a year. The research also stressed that there was usually a more favourable nutrient balance in soils where an intercrop or a rotation had taken place than where there was continuous maize cropping. Pigeon pea was liked very much because of its multi-purpose characteristics. It can be grown for soil fertility replenishment, used for food, as well as the stems used for firewood during the dry season.

The next visit was to some *Striga* and legume soil fertility interaction trials being conducted by Vernon Kabambe. In summary, his explanation was that continuous maize production without a trap crop such as groundnut would promote *Striga* infestation. Visits were also made to maize response to sulphur experiments being conducted on station and on farm in Lilongwe ADD by Allan Chilimba. These trials are meant to determine the maize yield response to sulphur and the optimal rate of sulphur application to maize in Malawian soils. At the end of the tour participants noted that there was very little visible difference in response to sulphur provided either as ammonium sulphate or from gypsum. On close inspection, some small differences in the maize crop could be observed between the rates of sulphur applied. Suggestions were made to improve the experiment in future by using pure elemental sulphur instead of the compounds to isolate the effects of other elements in compounds (such as from ammonia) when observing the sulphur response. This would avoid interacting effects of calcium from calcium sulphate and nitrogen from ammonium sulphate, which probably have an effect on yield additional to the sulphur alone.

On the second day, we visited on farm trials at Mbingwa in Dowa district. We first visited the maize variety performance demonstration plots being conducted jointly by SADLF, the Risk Project and DARTS in Chisepo. Among the varieties being compared were SC 627, Masika, ZM 521 and another open pollinated variety. The farmer indicated that ZM 521 was doing well, though from observation there was little difference between SC 527 and ZM 521.

On farm at Mbingwa, the residue effect trial gave an impression that the maize performed similarly in all plots under the different legumes, in contrast to on station trials that showed marked legume residual effects. We observed that the management of this on farm trial was poor and it was reported that the incorporation of legume residues was done late in the season. Weeding was also done very late. We were told that heavy rains, coupled with flooding in these areas, contributed to the poor performance of the maize in the trials. Crops in the individual (baby) demonstration trials appeared to be performing much better than those in the mother trials. This was very evident at Tiyamike CIMMYT group where we visited a first year sole legume demonstration plot. It was well laid out and weeded. Several legumes were performing very well. The farmer indicated that next year he would plant maize in all plots to see how the maize will respond to the legume residual effects. We questioned the farmer why his demonstration plot was doing much better than the corresponding mother trial. He indicated that the mother trials have leaders and his role is just to obey the instructions of the leaders. However, the chairman of the club pointed out clearly that in mother trials some people have a lot of excuses that lead to poor trial management. The farmer preferred baby trials to mother trials.

The visit to Mbingwa closed with a women's group performing traditional dances and songs praising the efforts of CIMMYT in assisting them with modern farming techniques to improve soil fertility. A well-equipped local band and a well phrased poem from a young boy spiced up the occasion, clearly showing that the Mbingwa farmers were well prepared for their visitors. We concluded the tour with discussions and dinner with the visiting Hunger Mission Task Force.

Workshop on Looking to the Future of Soil Fert Net

Soil Fert Net members had a very important meeting with John Lynam, the Rockefeller Foundation Food Security Program Associate Director with special responsibility for soil fertility, to review recent work and look to the future of Soil Fert Net.

About 28 persons (Table 6) took part in the meeting over three days (9 to 11 June) at the CIMMYT Offices in Harare. They represented Soil Fert Net member organizations in Malawi, Zimbabwe, Zambia and Mozambique, and

Table 6. Participants that attended the workshop on the Future of Soil Fert Net, Harare, Zimbabwe, 9-11 June 2003

Name	Discipline	Affiliation	Location
Aggrey Agumya	GIS	ICRAF	Harare, Zimbabwe
Paul Mapfumo	Soil science	Soil Science Dept, Univ Zimbabwe	Harare, Zimbabwe
John Dimes	Simulation/Soil science	ICRISAT	Bulawayo, Zimbabwe
Joseph Rusike	Agricultural economics	ICRISAT	Bulawayo, Zimbabwe
Danisile Hikwa	Agronomy	Agronomy RI, AREX	Harare, Zimbabwe
Obert Jiri	Agronomy	Agronomy RI, AREX	Harare, Zimbabwe
Tendai Gatsi	Agricultural economics	Agronomy RI, AREX	Harare, Zimbabwe
David Dhliwayo	Soil science	Chemistry and Soils RI-SPRL, AREX	Marondera, Zimbabwe
Malvin Mupandawana	Extension/Promotion	AFRICARE	Harare, Zimbabwe
Freddy Kwesiga	Agronomy/Management	ICRAF	Harare, Zimbabwe
Candida Cuembelo	Soil fertility	INIA	Maputo, Mozambique
Paramu Mafongoya	Soil science/Agronomy	ICRAF	Chipata, Zambia
Olu Ajayi	Agricultural economics	ICRAF	Chipata, Zambia
Crispin Kapunda	Agricultural economics	DR & SS, Mochipapa	Choma, Zambia
Moses Mwale	Soil fertility	DR&SS, Mount Makulu	Chilanga, Zambia
Obed Lungu	Soil science	School of Agriculture, Univ Zambia	Lusaka, Zambia
John Lynam	Agricultural economics	The Rockefeller Foundation	Nairobi, Kenya
Reneth Mano	Agricultural economics	Agric Econ Dept, Univ Zimbabwe	Harare, Zimbabwe
Sam Muchena	Breeding/Management	ACFD	Harare, Zimbabwe
Pauline Chivinge	Soil fertility	TSBF-CIAT	Harare, Zimbabwe
Herbert Murwira	Soil fertility	TSBF-CIAT	Harare, Zimbabwe
Webster Sakala	Agronomy	Maize Team, DARTS, Chitedze	Lilongwe, Malawi
Augustine Langyintuo	Agricultural economics	CIMMYT	Harare, Zimbabwe
Shephard Siziba	Agricultural economics	CIMMYT-Soil Fert Net	Harare, Zimbabwe
Stephen Waddington	Agronomy	CIMMYT-Soil Fert Net	Harare, Zimbabwe
Mulugetta Mekuria	Agricultural economics	CIMMYT-Soil Fert Net	Harare, Zimbabwe

several CG centres (ICRAF, TSBF-CIAT, ICRISAT and CIMMYT).

A series of summary presentations was made on the work of Soil Fert Net, under the following section headings:

⇨ Introduction and Overview by Soil Fert Net Coordination Unit
⇨ Bio-physical Research Activities of Soil Fert Net
⇨ Economics and Policy Working Group
⇨ Partnerships and Promotion of Best Bet Technologies
⇨ CG Centre Led Soil Fertility Research Projects.

John Lynam explained the Rockefeller Foundation Food Security Program strategy on soil fertility, which covers soil fertility research, technology dissemination, and fertilizer market development. Very fruitful group discussions were held with John on the work completed, remaining gaps, and future needs for 2004 and beyond. A major outcome of the meeting was an undertaking to develop the **Consortium on Soil Fertility Research and Development to Enhance Food Security in Southern Africa**. described earlier in this report.

Mini Symposium on Soil Fertility and Food Security for the Poor in Southern Africa

During the week of 16-22 August 2003, more than 800 prominent agricultural economists from all over the world converged at the Durban International Convention Centre, South Africa, for the 25th IAAE International Conference of Agricultural Economists, which is held every 3 years. The theme of the conference was **Re-shaping Agriculture's Contributions to Society.** Apart from the standard set of plenary, invited and contributed papers, posters and learning workshops, IAAE organized several mini symposia on key issues affecting agricultural development.

A proposal by Mulugetta Mekuria of Soil Fert Net-EPWG for a mini symposium on "**Soil Fertility and Food Security for the Poor in Southern Africa: Technical, Policy and Institutional Challenges"** was selected by the organizers. EPWG members also presented three posters at the conference.

The mini symposium was held on the afternoons of 19 and 20 August and attended by a diverse group of participants. It provided Soil Fert Net an opportunity to present its range of activities (both bio physical and socioeconomic), share and showcase our experiences at such a prestigious international conference.

Presentations were:

⇨ A Key Note Address on Soil Fertility, by Akin Adesina, Associate Director Food Security, Rockefeller Foundation, Nairobi

⇨ Technical Best-bet Options for Soil Fertility Management and Increased Food Security for Poor Farmers in Southern Africa, by Stephen Waddington Soil Fert Net Coordinator, CIMMYT, Harare

⇨ Integrating Socio economics, Policy and ISM Research and Capacity Building in Southern Africa: Lessons from EPWG-Soil Fert Net, by Mulugetta Mekuria, CIMMYT, Harare

⇨ The Economics of Soil Fertility Technologies for the Poor in Malawi: Implications for Food Security and Sustainability, by MAR Phiri et al., Bunda College of Agriculture, Malawi

⇨ Economics and Institutional Challenges Affecting Technology Adoption for Sustainable Development of African Agriculture: A Synthesis of Experiences from Zimbabwe, by Reneth Mano, University of Zimbabwe, Harare

⇨ Analysis of Trade Offs to Invest in Soil Fertility Management Technologies in the Semi Arid Tropics of Southern Africa- Joseph Rusike, ICRISAT, Bulawayo, Zimbabwe

⇨ Agroforestry Technologies for Improved Soil Fertility and Food Security for Poor Households in Africa: Their Geographical Niches, Adoption and Profitability, by Olu Ajayi et al., ICRAF, Chipata, Zambia.

The keynote address by Akin Adesina covered the policy challenges and research issues to solve the new type of poverty that smallholders in Sub Saharan Africa are trapped in. He calls it "Fertilizer Poverty".

Workshop on Policy and Advocacy to Enhance Adoption of Soil Fertility Technologies

Soil Fert Net convened a very successful regional workshop on *"Enhancing the Adoption of Soil Fertility Management Technologies for Sustainable Food Security in Southern Africa: The Role of Policy Instruments and Advocacy"*. It was held 24-28 November 2003, at Tuskers Hotel in Kabwe, Zambia. The regional workshop was organized in collaboration with Department of Agricultural Research and Specialist Services Crops and Soils Branch of Zambia. The Chief Agricultural Officer, Mr. Moses Mwale and his staff were responsible for local logistics and organization. Participants appreciated the excellent arrangements made for the workshop.

This regional workshop enabled 37 participants (Table 7) representing NARS, extension services, universities, farmers unions, NGOs and other invited researchers, policy makers and advisors from Malawi, Zambia and Zimbabwe to take stock of findings from ongoing technical research in soil science, agronomy and socio economics and policy related studies. Invited presentations from the MSU/Zambia Food Security Project, IFDC-Malawi, Policy Analysts from Zambia, Zimbabwe and Malawi provided an opportunity for better interaction between the diverse participants. Many participants also attended a half-day workshop on Fertilizer Marketing, Procurement and Distribution Policy in Zambia organized by the African Center for Fertilizer Development in Lusaka.

Objectives of the workshop were to:

⇨ Create a platform for ISFM researchers and policy analysts and policy makers

⇨ Discuss the status and contributions of SFM technologies to food security

⇨ Draw lessons from EPWG studies and the policy implications for SFM and food security

⇨ Identify policy instruments and measures required to enhance adoption of SFM technologies

⇨ Identify advocacy measures and strategies.

The workshop was structured under the following format with appropriate discussions and synthesis under each session.

⇨ Opening

⇨ Country Synthesis Presentations

⇨ EPWG Studies on Soil Fertility Technologies

⇨ Understanding the Policy Environment to Enhance SFMT Adoption in Southern Africa

⇨ Working Groups: Synthesis of SFM Technol-

Table 7. Participants that attended the Soil Fert Net Economics and Policy Working Group regional workshop on Enhancing the Adoption of Soil Fertility Management Technologies for Sustainable Food Security in Southern Africa: The Role of Policy Instruments and Advocacy. Held 24-28 November 2003, at Tuskers Hotel, Kabwe, Zambia

Name	Discipline	Affiliation	Country
Patricia Bwalya		FASAZ	Zambia
Jones Govereh	Agric Econ	Michigan State U/Food Security	Zambia
Petan Hamazakaza	Agronomy	DRSS, Min Agric	Zambia
Hyde Hantuba	Agric Econ	Policy & Planning, Min Agric	Zambia
Nsofwa Mulenga	Extension	TSB	Zambia
David Mundia	Agric Econ	Policy & Planning, Min Agric	Zambia
Kalaluka Munyinda	Soil Science	University of Zambia	Zambia
Bosco Mvula	Soil Science	DRSS, Min Agric	Zambia
Moses Mwale	Soil Science	DRSS, Min Agric	Zambia
Sam Phiri	Soil Science	DRSS, Min Agric	Zambia
Godfrey Sakala	Soil Science	DRSS, Min Agric	Zambia
Howard Tembo	Soil Science	DRSS, Min Agric	Zambia
Gelson Tembo	Agric Econ	Michigan State U/Food Security	Zambia
Thabbie Chilongo	Agric Econ	Bunda College, Univ Malawi	Malawi
Amon Kabuli	Agric Econ	Bunda College, Univ Malawi	Malawi
Ian Kumwenda	Agric Econ	MASIP, Min of Agric	Malawi
Peter Ngoma		Bunda College, Univ Malawi	Malawi
Alex Phiri	Agric Econ	Bunda College, Univ Malawi	Malawi
Webster Sakala	Agronomy	DARTS	Malawi
Hardwick Tchale	Agric Econ	Bunda College, Univ Malawi	Malawi
Davison Chikazunga	Agric Econ	University of Zimbabwe/SPRL	Zimbabwe
Tendai Gatsi	Agric Econ	University of Zimbabwe	Zimbabwe
Danisile Hikwa	Agronomy	AREX	Zimbabwe
Wellington Jogo	Agric Econ	University of Zimbabwe	Zimbabwe
Chipo Kangai	Agric Econ	University of Zimbabwe	Zimbabwe
Reneth Mano	Agric Econ	University of Zimbabwe	Zimbabwe
Paul Mapfumo	Soil Science	University of Zimbabwe	Zimbabwe
Washington Mashingaidze	Farmer	Zimbabwe Farmers Union	Zimbabwe
Mulugetta Mekuria	Agric Econ	CIMMYT-Soil Fert Net	Zimbabwe
Violet Muringai		University of Zimbabwe	Zimbabwe
Veronica Mutiro		Ministry of Lands & Agriculture	Zimbabwe
Charles Nhemachena	Agric Econ	TSBF-CIAT	Zimbabwe
Lovemore Rugube	Agric Econ	University of Zimbabwe	Zimbabwe
Shepard Siziba	Agric Econ	CIMMYT-Soil Fert Net	Zimbabwe
Stephen Waddington	Agronomy	CIMMYT-Soil Fert Net	Zimbabwe

ogy Options, Which are the Winning Best Bets?

⇨ Working Groups: Policy Constraints, Best-Bet Policy Prescriptions and Advocacy Strategy.

Dr Hyde Hantuba, Deputy Director Policy and Planning, Ministry of Agriculture of Zambia officially opened the workshop. Moreover, Dr. Hantuba fully and actively participated during the three days of the workshop and presented a paper on Economics and Policy Issues in Soil Fertility Management in Zambia.

Coordinator of Soil Fert Net, Stephen Waddington, gave a briefing on the development of the Soil Fertility Consortium. He indicated that this regional workshop was being held at a time when Soil Fert Net activities are coming to a close and the inception of a more comprehensive regional Consortium on Soil Fertility is being discussed with the assistance of the Rockefeller Foundation. Mulugetta Mekuria, Soil Fert Net Coordinator, highlighted the background on EPWG and the rationale and objectives for this Policy Awareness and Advocacy Workshop.

Day one was scheduled for presentations and discussions with specific focus on synthesis of the technical, policy and economic analysis of Soil Fertility Management Technologies undertaken by Soil Fert Net members, including biophysical scientists and EPWG grantees. The second day started with invited presentations from MSU/ Zambia Food Security Project on Fertilizer Profitability, Economics and Promotion of Conservation Farming in Zambia. These were followed by a series of presentations by EPWG members. On the third day, policy related papers from Zambia. Malawi and Zimbabwe were presented and discussed. Zimbabwe Farmers Union Vice President, Mr Washington Mashingaidze, gave a refreshing overview of the Union's effort to get input support from Government and the challenges researchers and development experts face to assist the resource poor and emerging commercial farmers in Zimbabwe. Three working groups based on technology types were formed to discuss and present a synthesis of SFM technology options, policy constraints and the possible advocacy strategies required to enhance the adoption of SFM technologies in Southern Africa. These reports are being synthesized and their content will be used to develop a series of expected policy briefs.

Network Publications

Target Newsletter — Issues 33 to 37 were produced in 2003-04 and each distributed to approximately 200 members.

Conference Proceedings — The proceedings of the Soil Fert Net conference on "Grain Legumes and Green Manures for Soil Fertility in Southern Africa: Taking Stock of Progress", held 8-11 October 2002 at the Leopard Rock Hotel, Vumba, Zimbabwe, were edited, compiled and printed during the report period.

The 246 page proceedings (ISBN 970-648-113-3) comprise 35 papers, including several key papers and reviews and a large number of offered papers. Also included are question and answer sessions, synthesis reports, and group planning reports. These proceedings document the tremendous amount of research work on green manures and grain legumes for soil fertility conducted in southern Africa in recent years. Much of this was under the auspices of Soil Fert Net.

Eight hundred copies were printed and these are being distributed early 2004.

External Conferences and Workshops Attended by the Coordinators

These included:

- CIMMYT Strategic Planning Meetings, 16-20 February, CIMMYT HQ, Texcoco, Mexico (SRW gave presentation on results from the Partnership and Networks Task Force).
- CIMMYT Project and Strategic Planning Meetings, 17-23 March, CIMMYT HQ, Texcoco, Mexico (SRW gave presentation on the achievements of CIMMYT Regional Project 1 and the future of our work for SS Africa).
- Conservation Agriculture Project Planning Workshop, 12-14 May, Harare, Zimbabwe (SRW and MM)
- 25th IAAE International Conference of Agricultural Economists, Durban, South Africa, 16-22 August 2003 (MM, SRW and Shephard Siziba).
- Risk Management Project Stakeholder Workshop 25-27 September, Harare, Zimbabwe (SRW and Shephard Siziba).
- CG Water and Food Challenge Program Baseline Conference, 2-6 November, Nairobi, Kenya (SRW).
- African Conservation Tillage Network Phase 2 Planning Workshop, 11-13 November, Harare, Zimbabwe (SRW).

Most of the above travel and participation was funded outside of Soil Fert Net.

Soil Fert Net was able to help Regis Chikowo, Universities of Zimbabwe and Wageningen to attend the 6th African Crop Science Society Conference, held in Nairobi, Kenya 11-17 October 2003, by providing registration fees and accommodation costs.

The coordinators described Soil Fert Net work to numerous visitors to the CIMMYT Harare station during the report period. The demonstration of legume and biomass transfer interventions was conducted again at the station and it served as a focal point for some visitors. Several groups of students visited from the University of Zimbabwe and elsewhere. Waddington was external examiner in December 2003 for an MPhil degree on the mineral nutrition of mucuna as a ley crop in smallholder farming systems, by Obert Jiri at the University of Zimbabwe.

Network-Related Papers with a Contribution from the Coordinators

Kamanga, B.C.G., Z. Shamudzarira, and S.R. Waddington (2003). On-farm comparison of fertilizer application practices to assess nitrogen-use efficiency with maize in Zimuto communal area, Zimbabwe. Risk Management Working Paper Series 03/01. CIMMYT, Harare, Zimbabwe. 21 p.

Karigwindi, J. and Waddington, S. (2004). Performance of maize germplasm under stress at Domboshava, Zimbabwe, and Dwarf maize: A good friend to intercropped grain legumes? *Target, Soil Fert Net Newsletter* 37:4-5.

Morris, M.L., Mulugetta Mekuria, and R. Gerpacio (2002). *Impacts of CIMMYT's maize breeding program.* Forthcoming in B. Evenson and D. Gollin (eds.). *Impact of the CGIAR on international crop genetic improvement.* Wallingford, UK: CABI.

Mulugetta Mekuria and S. Siziba (2003). Financial and risk analysis to assess the potential adoption of green manure technology in Malawi and Zimbabwe. In: *Grain Legumes and Green Manures for Soil Fertility in Southern Africa: Taking Stock of Progress.* Waddington, S.R. (ed.). Proceedings of a Conference held 8-11 October 2002 at the Leopard Rock Hotel, Vumba, Zimbabwe. Soil Fert Net and CIMMYT-Zimbabwe, Harare, Zimbabwe. pp. 215-221.

Siziba, S. and Mulugetta Mekuria (2003). Soil fertility management and maize production in southern and central Mozambique: Highlights from the informal exploratory survey. *Target, Soil Fert Net Newsletter* 34:3-4.

Siziba, S. and Mulugetta Mekuria (2003). Adoption of soil fertility technologies in the northern and southern provinces of Zambia. *Target, Soil Fert Net Newsletter* 36:6-7.

Thorne, P.J., Thornton, P.K., Kruska, R.L., Reynolds, L., Waddington, S.R., Rutherford, A.S., Odero, A.N. (2002). Maize as food, feed and fertiliser in intensifying crop-livestock systems in East and Southern Africa: An *ex ante* impact assessment of technology interventions to improve smallholder welfare. ILRI Impact Assessment Series 11. ILRI (International Livestock Research Institute), Nairobi, Kenya, 123 pp.

Waddington, S.R. (2003). How about integrating conservation tillage and water management with soil fertility for smallholder maize-based cropping systems in southern Africa? *Target, Soil Fert Net Newsletter* 35:6-11.

Waddington, S.R. (ed.) (2003). *Grain Legumes and Green Manures for Soil Fertility in Southern Africa: Taking Stock of Progress.* Proceedings of a Conference held 8-11 October 2002 at the Leopard Rock Hotel, Vumba, Zimbabwe. Soil Fert Net and CIMMYT-Zimbabwe, Harare, Zimbabwe. 246 pp.

Presentations —

Gatsi, T. and S. Siziba. Comparative Analysis of Green Manures: A Case Study of Zimbabwe and Malawi. Presented at the Soil Fert Net Workshop, Enhancing the Adoption of Soil Fertility Management Technologies for Sustainable Food Security in Southern Africa: The Role of Policy Instruments and Advocacy. Held 24-28 November 2003, at Tuskers Hotel, Kabwe, Zambia.

Mulugetta Mekuria and S. Siziba. An application of financial and risk analysis in assessing the potential adoption of green manure technology in Zimbabwe and Malawi. Contributed paper presented at the 25th IAAE International Conference of Agricultural Economists, Durban, South Africa, 16-22 August 2003.

Mulugetta Mekuria. Integrating Socio economics, Policy and ISM Research and Capacity Building in Southern Africa: Lessons from EPWG-Soil Fert Net. Paper presented in the mini symposium on "Soil Fertility and Food Security for the Poor in Southern Africa: Technical, Policy and Institutional Challenges", 25th IAAE International Conference of Agricultural Economists, Durban, South Africa, 16-22 August 2003.

Waddington, S. Soil fertility technologies. A presentation to the Crop Science Society of Zimbabwe. February 2003.

Waddington, S. Technical Best-bet Options for Soil Fertility Management and Increased Food Security for Poor Farmers in Southern Africa. Paper presented in the mini symposium on "Soil Fertility and Food Security for the Poor in Southern Africa: Technical, Policy and Institutional Challenges", 25th IAAE International Conference of Agricultural Economists, Durban, South Africa, 16-22 August 2003.

Waddington, S. Soil Fert Net 2004 and Beyond. Presented at the Soil Fert Net Workshop, Enhancing the Adoption of Soil Fertility Management Technologies for Sustainable Food Security in Southern Africa: The Role of Policy Instruments and Advocacy. Held 24-28 November 2003, at Tuskers Hotel, Kabwe, Zambia.

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Mulugetta Mekuria, Agricultural Economist (50% time)
Shephard Siziba, Economics Research Associate
Johannes Karigwindi, Research Assistant
John Chifamba, Recorder/Field Assistant
Tsungai Gumbo, Secretary (50% time)
Nothando Moyo, Secretary (50% time)

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SRW and MM, Harare, 10 March 2004

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