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SOIL FERT NET ANNUAL REPORT FOR 2001

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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

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

"Soil Fert Net"

Annual Report for 2001

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Highlights of Soil Fert Net in 2001

- A new management structure for Soil Fert Net, with broader responsibilities for members was developed and implemented
- Four additional Soil Fertility Best Bets were identified for Southern Africa:
    1. Anaerobically-composted cattle manure for Zimbabwe
    2. Groundnut + pigeonpea intercrop rotation with maize for Malawi
    3. *Crotalaria grahamiana* and *C. ochroleuca* green manures
    4. *Tithonia* spp. leaf prunings
- Several Best Bet soil fertility technologies were officially released in Malawi
- A wider integration across disciplines, institutions and countries was achieved, including in an "East meets South" workshop and the development of integrated proposals (in Zambia and Zimbabwe)
- Natural resource economics training was incorporated into our work
- Four major research projects began under our Economics and Policy Working Group, and seven new proposals were discussed
- The Soil Fert Net web site, www.Soilfertnetsouthernafrica.org, was developed and became available online
- Inventories of Soil Fert Net research and extension work are under development
- Soil Fert Net members from Malawi and Zimbabwe participated in Rockefeller Foundation Reviews of Soil Fertility Work and in a Sustainable Livelihoods Consultancy.

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Introduction

The work of the Soil Fertility Research Network for Smallholder Maize-Based Farming Systems in Southern Africa (Soil Fert Net) strengthened significantly during 2001. Our new strategy for the period 2001-2003 (described in the 2000 Annual Report) was implemented. Funding from the Rockefeller Foundation increased to US$ 456600 for the period 1 December 2000 to 30 November 2001. Support to various forms of socio-economic work increased substantially. The time allocation for the Coordination Unit agricultural economist rose to 50%. Additionally, we recruited an agricultural economics research associate (Shephard Siziba). These positions are based at CIMMYT-Zimbabwe.

This report outlines new developments in Soil Fert Net during 2001, summarizes network research and technology promotion initiatives and describes a significantly expanded portfolio of networking events. Some of the highlights of our work in 2001 appear on the previous page. Table 1 gives a summary of the major Network events held during the report period. We begin with a description of our new management structure, developed and implemented in 2001.

Developments with Soil Fert Net in 2001

New Management Structure

Soil Fert Net is now a mature and expanded network. To date, the Soil Fert Net has relied on direct contact between interested groups of members and the coordinators to develop most of our activities. This flexible and responsive approach has proved highly effective. However, as the Network has grown in geographic and disciplinary coverage this mode of operating is under strain.

Accordingly, early in 2001 Soil Fert Net decided to put in place a simple and efficient management structure that will take us forward as a Network to address new challenges. Some 16 key members of Soil Fert Net attended a Management Planning Meeting near to Harare on 6-7 February 2001 to develop the new management structure for Soil Fert Net (Table 2).

The aims of the structure is to better focus and manage resources on priority thrusts, empower members by spreading points of initiative within the Network, and increase ownership and accountability to improve the regional sustainability of our Network.

Participants said the structure must be flexible, sustainable, functional and not costly to run. The structure shown in Figure 1 was agreed. The components are given below.

Regional Coordination Unit (RCU) — This will continue to facilitate network activities from CIMMYT.

The RCU will:
- Administer the network
- Coordinate regional staff
- Communication and strategy implementation
- Develop the Network
- Provide technical backstopping.

Table 1. Main Soil Fert Net Events in 2001

Type of Event	Title	Dates	Location
Management Meetings:	Soil Fert Net Management Planning	6-7 February	Lake Chivero, Harare, Zimbabwe
	Zambia Planning and Project Development	3-4 October	Lusaka, Zambia
Field Tours:	Available Soil Fertility Practices	19-21 February	Central Malawi
	Integrated Soil Fertility Research	3-11 March	Northern Zambia
Workshops:	East Meets South - Strengthening Ties and Synergies	10-12 May	Arusha, Tanzania
	Understanding the Adoption and Impact of Soil Fertility Technologies	3-6 December	Juliasdale, Zimbabwe
Training Workshop:	Learning Workshop on Economic Evaluation of Natural Resources and Soil Fertility	2-7 April	Pretoria, South Africa

Table 2. Participants that attended the Soil Fert Net Management Planning Meeting, Lake Chivero, Harare, Zimbabwe, 6-7 February 2001

Participant	Discipline	Affiliation
M Alex Phiri	Agricultural Economics	Bunda College, Univ. of Malawi, Lilongwe
Allan Chilimba	Soil Science	Chitedze Research Station, DARTS, Lilongwe
Webster Sakala	Agronomy	Chitedze Research Station, DARTS, Lilongwe
Moses Mwale	Soil Science	Soil & Water Branch, DR&SS, MAFF, Lusaka
Abraham Ngoliya	Farming Systems	DR&SS, MAFF, Mansa, Zambia
Ostin Chivinge	Agronomy	Faculty of Agriculture, Univ. of Zimbabwe, Harare
Danisile Hikwa	Agronomy	Agronomy Institute, DR&SS, Harare
David Dhliwayo	Soil Science	Chemistry and Soils, DR&SS, Marondera, Zim.
Reneth Mano	Agricultural Economics	University of Zimbabwe, Harare
Sheunesu Mpepereki	Soil Science	University of Zimbabwe, Harare
Elias Ayuk	Agricultural Economics	ICRAF, Harare
Herbert Murwira	Soil Science	TSBF, Harare
Akinwumi Adesina	Agricultural Economics	The Rockefeller Foundation, Harare
Steve Twomlow	Agronomy/Soils	ICRISAT, Matopos, Bulawayo
Mulugetta Mekuria	Agricultural Economics	CIMMYT-Zimbabwe/Soil Fert Net, Harare
Stephen Waddington	Agronomy	CIMMYT-Zimbabwe/Soil Fert Net, Harare

The SAC will:
- Monitor and evaluate projects
- Provide leadership in agricultural research related to soil fertility
- Assist thematic leaders in reviewing proposals as they arise, i.e. carry out the final review of some proposals
- Help set strategic research agenda on soil fertility to encompass adaptive and applied research.

Regional Theme Leaders (RTLs) — These will be drawn from the thematic areas of research to coordinate and develop regional work.

RTLs will:
- Provide leadership within the theme group
- Convene regional meetings on the theme
- Review and screen proposals on the theme
- Assist the RCU in technical administration related to the thematic areas
- Form task forces within each theme, e.g. on biological N fixation, organic x inorganic mixes, soil fertility rehabilitation strategies.

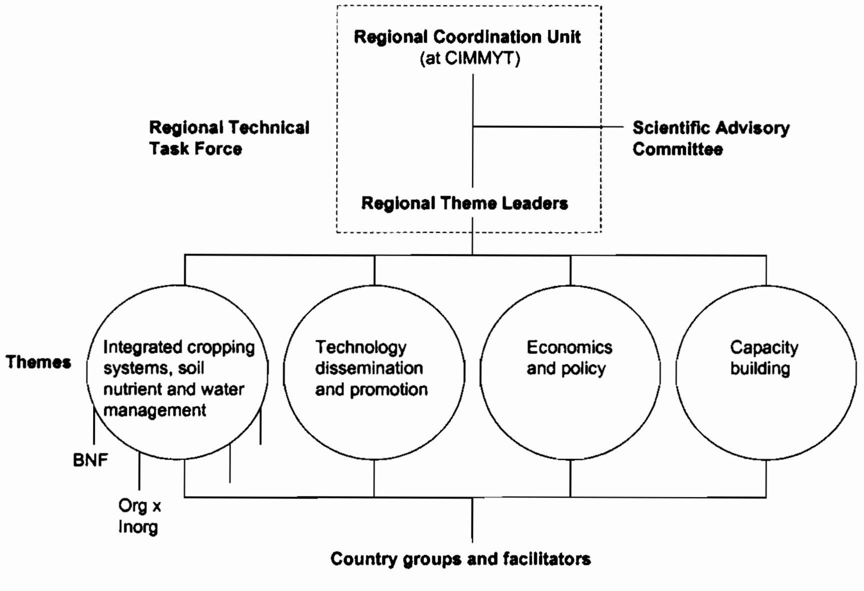


Figure 1. New Soil Fert Net Management Structure, 2001-03

Scientific Advisory Committee (SAC) — The SAC is to provide strategic leadership for Soil Fert Net. It will be composed of eminent scientists that are active in research in their own right. They will provide independent views on projects. The composition of SAC will have persons drawn to cover different thematic areas of the network. The choice of SAC members is to be done by the network. The Rockefeller Foundation has a similar system with the Forum.

Regional Technical Task Force (RTTF) — This is a "virtual" committee that is informal. It is made up of the RCU, RTLs and the donor representative.

The RTTF will:
- Provide first-point-of-call peer review of proposals
- Develop methodology and general capacity building in the various thematic areas
- Monitor project trends and write information briefs

• Share information across thematic areas.

The meeting developed the following guidelines for Regional Theme Leaders.

Criteria for nominating thematic leaders:
- Active involvement in the network
- Demonstrable capacity to conduct work on the ground and coordinate activities on a theme
- Publications in the thematic area
- Willingness and ability to serve.

Selection of thematic leaders:
- Ensure a regional balance in thematic leadership
- The RCU to work with various names and come up with a balanced, but effective leadership for the themes.

Term of office:
- The term of office is to be specific, i.e. 3 years
- Any non-performers are to be relieved of duties without necessarily waiting for end of their term.

National Facilitators — It was realized that national links within the Network would depend on country circumstances. Where possible, existing structures such as the Malawi Maize Productivity Task Force should be strengthened rather than new bodies set up. The meeting felt that two National Facilitators (Liaison Persons) should be identified per country. One will cover the biophysical sciences and the second one on socio-economics and policy, and both will ensure disciplinary interaction.

In-country meetings of members are to be convened to decide on facilitators. It is important to ensure that there is enough representation from economics and biosciences to attend the meeting. The RCU was asked to contact Mozambique to formalize their involvement.

Proposal review system —
- This must be flexible. Individuals should know that they could add value to their proposals by subjecting them to peer reviews and incorporating the suggestions. The network will provide peer reviewing for those that require it.
- The network should develop focussed guidelines on proposal write-up to help network members develop good proposals.
- The network encourages members to submit proposals to other donors as well as the Rockefeller Foundation.

Followups — The coordinators solicited nominations from members for possible persons that may serve at RTLs and on the SAC. Webster Sakala of DARTS, Malawi agreed to serve as the RTL covering Integrated Cropping Systems, Soil Nutrient and Water Management. Ishmael Pompi of DR&SS, Zimbabwe was appointed the Technology Dissemination and Promotion RTL. These positions became effective 1 September 2001. One of the first tasks identified by the RTLs is a new database on research and dissemination activities being undertaken by members of Soil Fert Net. Interest was expressed by several persons nominated for the SAC. Implementation of the SAC will begin formally early in 2002.

Soils Research in East and Southern Africa: Strengthening Ties and Synergies Workshop

Many institutions conduct research on various aspects of soil fertility and its management in East and Southern Africa. Sometimes this research could duplicate past or even current efforts. There is a growing need to assure that these research efforts are complementary and not competitive, that the sum of output of all the work provides a thorough understanding of the problem and promotes adoptable solutions to the problems of soil fertility and conservation.

Thus two of the main soil fertility networks in the region, the TSBF African Network (AfNet) and SoilFertNet, hosted a two-day workshop to bring together key institutions involved in soils research in East and Southern Africa. Forty-one key participants attended the meeting held on 11 and 12 May 2001 in Arusha, Tanzania. They were drawn largely from AfNet, with about ten members from SoilFertNet (Table 3). There was strong representation from government research institutions and universities in Eastern and Southern Africa, from several NGOs, from IARCs and from the Rockefeller Foundation. Some colleagues from West Africa attended the first day. The purpose was to discuss current soils research and make plans for future collaborative efforts.

The **objectives and outputs** of the workshop and agenda were:

1) Revised lists of thematic research topics, including recommendations, gaps, dissemination and policy issues,
2) A set of research priorities identified within each of the themes and mechanisms for

integration of the various institutions and individuals working on the theme,
3) Identification of cross-cutting topics that link themes and regions, and
4) Agreement on mechanisms to improve collaboration and the coherence of the research effort.

Those same group meetings then went on to look in more detail at the requirements for further work, with emphasis on those that lend themselves toward joint initiatives across southern and eastern Africa.

The meeting was structured around seven common research themes that served as a point of reference for forming closer alliances and achieving a coherent and complementary research process that builds on the comparative advantages of the different players. The themes were as follows:

- Legumes: types, niches and management
- Organic + inorganic nutrient combinations
- Rock phosphate
- Livestock and soil fertility: manure quality and management
- Nutrient budgets of agroecosystems
- Socio-economics and policy research
- Technology testing and dissemination

To initiate the discussions, leaders of thematic groups had been assigned the task of compiling a first draft of research in each theme including current understanding, research gaps, dissemination, and policy issues. These draft inventories were presented at the workshop and were updated and amended by the participants both through plenary sessions and through thematic working groups.

Table 3. Participants that attended the "East Meets South" Workshop on the Integration of Soil Research Activities in Eastern and Southern Africa, held in Arusha, Tanzania, 10-11 May 2001

Participant	Affiliation
Tilahun Amede	CIAT/AHI, Awassa, Ethiopia
Vincent Bado	INERA, Bobo-Dioulasso, Burkina Faso
André Bationo	TSBF AfNet Coordinator, Nairobi, Kenya
Stephen M. Nandwa	NARL, KARI, Nairobi, Kenya
Dennis K. Friesen	CIMMYT, Nairobi, Kenya
Charles K.K. Gachene	University of Nairobi, Nairobi, Kenya
Stephen Kimani	NARL, KARI, Nairobi, Kenya
Bashir Jama	ICRAF, Nairobi, Kenya
John Lynam	The Rockefeller Foundation, Nairobi, Kenya
Cheryl Palm	TSBF, Nairobi, Kenya
John Ojiem	KARI Regional Research Centre Kakamega, Kenya
Joseph Mureithi	KARI, Nairobi, Kenya
Paul Seward	SCODP, Nairobi, Kenya
Martins Odendo	KARI Regional Research Centre Kakamega, Kenya
Daniel N. Mugendi	Kenyatta University, Nairobi, Kenya
Mike Swift	TSBF, Nairobi, Kenya
Bharati Patel	The Rockefeller Foundation, Nairobi, Kenya
Bernard Vanlauwe	TSBF, Nairobi, Kenya
Joshua Ramisch	TSBF, Nairobi, Kenya
Webster Sakala[SF]	Chitedze Research Station, DARTS, Lilongwe, Malawi
M. Alexander Phiri[SF]	Bunda College, University of Malawi, Lilongwe, Malawi
Ruben Puentes	The Rockefeller Foundation, Mexico DF, Mexico
Jan Diels	IITA, Ibadan, Nigeria
Johnson Semoka	Sokoine University of Agriculture, Morogoro, Tanzania
Frederick Baijukya	ARDI, Maruku, Bukoba, Tanzania
Nuhu Hatibu	Soil Water Management Res. Group, Morogoro, Tanzania
Susan T. Ikerra	Dept. Soil Science, Sokoine Univ of Agriculture, Morogoro Tanzania
Chaboba Mkangwa	Dept. Soil Science, Sokoine Univ of Agriculture, Morogoro Tanzania
Jeremias G. Mowo	Directorate of Research & Development, Tanga, Tanzania
B.K. Tossah	Institut National de Recherche Agronomique (ITRA), Lomé, Togo
Mateete Bekunda	Dept of Soil Science, Makerere University, Kampala, Uganda
Rob Delve	TSBF-CIAT, Kampala, Uganda
Mary Rwakaikara-Silver	Department of Soil Science, Makerere University, Kampala, Uganda
Moses Mwale[SF]	DRSS, MAFF, Mt. Makulu C.R. Station, Chilanga, Lusaka, Zambia
Paul Mapfumo[SF]	Dept of Soil Science, University of Zimbabwe, Harare, Zimbabwe
Herbert H. Murwira	TSBF, Harare, Zimbabwe
Obert Jiri[SF]	DR&SS Agronomy Research Institute, Harare, Zimbabwe
Reneth Mano[SF]	Dept. Agric Economics, University of Zimbabwe, Harare, Zimbabwe
Ken Giller	Dept. of Soil Science, University of Zimbabwe, Harare, Zimbabwe
Mulugetta Mekuria[SF]	CIMMYT-Zimbabwe/Soil Fert Net, Harare, Zimbabwe
Stephen Waddington[SF]	CIMMYT-Zimbabwe/Soil Fert Net, Harare, Zimbabwe

[SF] = Sponsored by Soil Fert Net

In addition to the thematic groups, there were discussions on the integration of research and dissemination under the topics of integrated nutrient management, the institutional considerations of integrated research and dissemination, and the information services and flows needed to assure the integration of research and dissemination.

A very positive and cooperative atmosphere throughout marked the meeting.

Thematic Presentations and Working Groups — Detailed thematic inventories, that include the inputs from the working group sessions, were developed. A wide variety of dissemination techniques is being practiced in the regions but it was felt that this expertise was not represented at the meeting. There is need in the region to share experiences on the strengths and weakness of the different dissemination methodologies and to provide guidance for the circumstances where they are applicable.

Descriptions of the priority research topics and plans for follow up within each of the different themes were included in the inventories. Highlights for further joint work included:

- Development and distribution of comprehensive cross-regional reviews and syntheses of a) phosphate rock and b) annual legumes, by leading players in southern and eastern Africa.
- Systematic spatial integration of new and well-researched legumes into agroecological and socio-economic farming systems in southern and eastern Africa and quantification of their short term N contribution and longer term sustainability contribution to the farming systems.
- Emphasis on the regional development and use of decision support guides which includes both biophysical and socio economic criteria on a range of soil fertility inputs, including organic manures of various qualities (including green and animal manures) and phosphate rock.
- Integration of livestock research into the organic-inorganic nutrient sources and legume themes.
- Integration of socio-economic research into all of the research themes.
- Although not universally endorsed, there were sentiments that research work on phosphate rock and nutrient budgets should now be scaled back, with future emphasis on the use of the results.

Challenges and Follow-up — Final challenges to the workshop were to produce the thematic syntheses, develop a more system-orientated approach for the major agroecosystems in the region, engage in modelling activities for agroecosystem analysis, focus on farmers, and focus on developing appropriate dissemination methodologies — less progress has been made in this area and it is probably the most crucial.

AfNet and SoilFertNet agreed to continue to coordinate efforts between the two regions. The new structure of SoilFertNet with regional themes and leaders will serve as a useful framework for this regional effort. Written and Email reports from the East Meets South meeting were widely distributed and a colour booklet of the findings was produced. AfNet is working on the development of the technology decision guides. A joint book on legume technologies is under development. SoilFertNet are developing a review of these technologies in southern Africa and plan a conference on annual legumes for 2002.

Rockefeller Foundation Soil Fertility Research Review in Zimbabwe and Malawi

During 2001, the Rockefeller Foundation conducted a major review of its investments in Soil Fertility Research in Africa. This review was developed to assist the Foundation to strategically evaluate the effectiveness of its soil fertility grants and to identify new areas for the targeting of future investments. Reviews were first undertaken in Kenya and Uganda where the Foundation has also been supporting a great deal of soil fertility work.

Very successful stakeholder workshops were conducted in Zimbabwe (29 October–2 November) and Malawi (5-7 November) as part of this process. In each case, some 50 participants attended, drawn from a wide range of institutions. Many were Soil Fert Net members. This was an extremely important review process for our members to show the value and relevance of a major part of our lives and also to maintain and develop support to take this work further.

Grantees and their existing and potential partners presented and discussed their work. Participants were involved in a series of working group sessions to develop strategies for the future. The sessions went well into the evening on several days.

Members of the external review panel, chaired by Prof. Erick Fernandes of Cornell University, and comprising Jo Anderson, Nteranya Sanginga, Dunstan Spencer, Eric Smaling and Marjatta Eilitta, attended the meetings, and were finalising their recommendations, to be presented very early 2002.

Sustainable Livelihoods Consultancy

DfID supports most of the maize breeding work conducted by CIMMYT-Zimbabwe for southern and eastern Africa. DfID were keen to see how well the work they support at CIMMYT fits into the sustainable livelihoods approach which is now the framework for their development initiatives. They agreed to fund a consultancy to do this. The parties were interested to add an extra case study to the consultancy and so Soil Fert Net took advantage of the offer. Two consultants, Alistair Sutherland of NRI and Robert Tripp of ODI, visited the region in May 2001.

Many recommendations were given on how to better incorporate a poverty and sustainable livelihoods focus into the soil fertility and natural resource management work of CIMMYT-Zimbabwe, which is done principally through Soil Fert Net. Follow-up discussions in January 2002 led to decisions that the EPWG will encourage members to more explicitly incorporate farmer poverty grouping into their work. Additionally, we plan a Learning Workshop on Poverty Analysis for August 2002, using surveys and other results from Chihota, Zimbabwe as a case study. This will involve staff from NRI among the resource persons. They will part self-fund their participation.

Consultative Process to Develop a Strategy for an Integrated Soil Fertility Research Programme in Zimbabwe Beyond 2000

Following a comprehensive review in 2000, DR&SS Zimbabwe are developing a new proposal for integrated soil fertility work.

As part of the consultative process with interested parties, a workshop was held in Harare 27-28 February to learn about related work and plan out content for a strategy document for an Integrated Soil Fertility Research Programme Beyond 2000. Some forty persons attended from many organizations, reflecting the breadth of interest in the subject.

Soil Fert Net Activities for 2002

Table 4 provides an outline of the major events and activities for Soil Fert Net in 2002. Some of these will be modified and others added later as the network evolves during the year.

Network Research

Four start-up or top-up grants were provided from the Soil Fert Net networking grant during 2001 to members to support mutually agreed high priority network research (Table 5). Four Soil Fert Net Economics and Policy Working Group research projects that were approved for the 2001-2002 season were funded by the Rockefeller Foundation and are underway in Zimbabwe and Malawi. The researchers presented their progress and initial findings from their research activities at the Regional Adoption and Impacts of Soil Fertility Technologies Workshop held on 3-6 December 2001 at Juliasdale, Zimbabwe.

Table 4. Proposed Soil Fert Net Workshops and Field Tour, 2002

Topic	Venue	Dates
7th Eastern and Southern Africa Regional Maize Conference, and Symposium on Low-N and Drought Tolerance	Nairobi, Kenya	11-15 February
Field Tour in Mozambique	Tete and Manica Provinces	Early April
Soil Fertility Workshop for Policy Makers	Lilongwe, Malawi	June
ICRAF Southern Africa Regional Agroforestry Conference	Pretoria, South Africa	20-24 May
Learning Workshop on a Poverty Focus and Sustainable Livelihoods	Zimbabwe	August
Grain Legume and Green Manures Conference	Zimbabwe	9-11 October
Dissemination and Promotion Meeting	Lusaka	Late 2002

Table 5. Soil Fert Net Start Up or Top Up Grants, 2001

Subject	Country	Institution	Lead Person
Combating Soil Fertility Decline in Different Farming Systems of Zambia	Zambia	Soil and Water Branch, DR&SS	Moses Mwale
Development of N response curves for NUE maize	Zimbabwe	Agronomy Institute, DR&SS	Lucia Muza
Liming equivalency of organic materials found in the smallholder sector	Zimbabwe	Soil Productivity Research Laboratory, DR&SS	Nhamo Nhamo
Amendment of sulphur nutrient deficiency in maize production	Malawi	Soils Commodity Team, DARTS	Allan Chilimba

As in previous years, most of the research by members of Soil Fert Net was conducted using funds provided directly to grantee organizations by the Rockefeller Foundation. An important function of the Network remains to help members develop research proposals on priority topics, manage their review and upgrading, and in some cases their submission to the Rockefeller Foundation to be considered for funding.

In this section we provide short progress reports on the start-up projects and on the EPWG projects.

Managing Soil Fertility Decline in Different Farming Systems of Zambia

(Moses Mwale and Team)

The Department of Research and Specialist Services of Zambia received US$7000 from the Soil Fert Net as start up funds in the year 2001. This money has been used to establish experiments which, hopefully, will be funded by the Rockefeller Foundation when the proposal currently under consideration is approved. The proposal seeks to formulate strategies through a multifaceted approach to cover a wide range of soil fertility related production problems.

Improved fallow and green manure experiments have been set up in Northern, Central and Southern Zambia. The green manure species include Velvet bean, Sunnhemp, *Tithonia diversifolia* and Pigeonpea. *Tithonia* cuttings collected from Isoka District have been used to establish a *Tithonia* biomass bank at Misamfu station, Kasama. This will be used later as a source of materials for testing and establishing quality parameters of *Tithonia*. Screening of *Crotalaria* species was done in Northern Zambia. Of the three species used, *C. ochreleuca, C. zanzibarica and C. juncea, zanzibarica* was found to be the most suitable followed by *C. ochreleuca* for the acidic soils. Maize has been planted in the plots that had green manures in the last season.

Collection of seed material of the various multipurpose tree species to be used in the project was done. Seeds of *Cajanus cajan, Tephrosia vogelii, Gliricidia sepium* and *Leucaena collinsii* were collected. Seedlings of each species of *Gliricidia sepium, Sesbania sesban, Tephrosia vogelii* and *Leucaena collinsii*, were raised. Some of these were planted in experiments towards the end of 2001. Multipurpose tree experiments established in December 2000 are in the 1-year fallow phase. It was necessary to establish these trees because some measurements will be made on them once the project begins. This will help cut on time.

Improvement in soil chemical and physical properties is being monitored. An effort was made to put these trials/demonstrations at farmer training centres (FTCs) to enable farmers to have easy access to them. A survey of the area where *Fundikila* and *Chitemene* systems are practiced was conducted in March 2001.

Isolation and maintenance of rhizobium strains in the laboratories at Misamfu and Mt. Makulu was conducted. Rhizobium strains for *Gliricidia sepium, Sesbania sesban, Glycine max* and *Phaseolus vulgaris* were maintained. The other activity was the production of inoculants for the inoculation of trees that were raised in the nurseries.

Some on-farm soybean inoculation demonstrations were conducted in nine districts of Zambia. These were Kasama, Mungwi, Chinsali, Isoka, Nakonde, Mpongwe, Katete, Mkushi and Chipata. Some of the results from these demonstrations are as shown in Figure 2. The results showed that the inoculated treatments were as good as the fertilized treatments which were both better than the non inoculated control at most sites. These results, obtained in farmer's fields, are helping popularize the use of inoculum in the country.

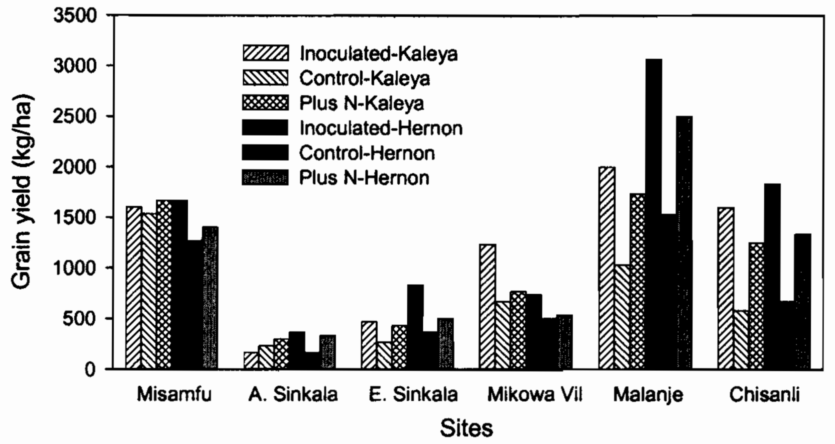


Figure 2. Influence of inoculum on soyabean yield in Northern Zambia

Twenty nine smallholder farmers from Region I were recruited to establish demonstrations of pit farming in the 2000/2001 season. Farmers whose fields were near to water points were purposefully taken so that they could practice off season cropping. An excursion to a pit farming site was undertaken to expose farmers to this type of farming. The farmers were shown the process and art of preparing pits. Among the participants were 10 camp extension officers who later took over the supervision of farmers in this farming practice. All the farmers selected, except two, had prepared the pits. Maize has been planted in the pits in the 2001/2002 season. Results will be reported later.

Some funds were also used in the preparatory work for the Soil Fert Net tour, which was conducted in Northern Zambia in March 2001, and on meetings to write up the proposal that has been submitted to the Rockefeller Foundation for consideration.

Sulphur Nutrient Deficiency in Malawi Maize Production (Allan D.C. Chilimba, Webster D. Sakala and Vernon H. Kabambe)

Introduction — Maize remains the most important staple food crop for Malawi. Sulphur research as a soil nutrient for maize production in Malawi was masked by strong emphasis on N followed by P as the most important nutrients for maize production. S is essential in plant protein synthesis because it is part of certain amino acids. It also helps form enzymes, vitamins and is necessary for chlorophyll formation. S deficient plants show a pale green colour, generally appearing first on younger leaves. N and S deficiency symptoms look similar to many people and usually S deficiency symptoms are taken for N deficiency, hence in most cases, efforts are made to address N deficiency instead of addressing S deficiency.

In recent years, atmospheric pollution by SO_2 in smoke has been much more strictly controlled than previously. The amount of S available to crop plants from the atmosphere has been reduced. The situation is aggravated because the consumption of S containing fertilizers is decreasing, particularly the use of ammonium sulphate and superphosphate. The depletion of soil organic matter through continuous cultivation with little or no incorporation of organic materials into the soil has led to S mining from the soil. S application to crops is thus becoming increasingly common. The total S requirement of different crops depends on plant material production and on the crop species. Crops with a high biomass production such as sugar cane, maize and Bermuda grass have a high demand for S, which is around 30 to 40 kg S/ha/yr.

S deficiencies show up most often on sandy soils, low in organic matter, in areas of moderate to heavy rainfall. A considerable quantity of S is tied up in soil organic matter. Soil organic matter is the major source of soil S in most soils. S occurs in the soil in inorganic and organic forms. In most soils organically bound S provides the major S reservoir. The C:N:S ratio in soil organic matter is approximately 125:10:1.2.

Although N is the most limiting nutrient in Malawi, more than 50 years ago, S deficiency was observed in tea plants in Malawi and the deficiency became known as “tea yellows”. S deficiency in Malawi soils was also observed in 1964 and it was noted that soils in the central and southern Malawi were low in total and available S and that S application increased grain yield. The areas where crop response to S addition was observed are in the South Rukuru Valley, Mzimba Hills, Kasungu Plain, Dzalanyama and Dedza Hills. There are also reports of a frequent and significant yield response to S application in Shire Highlands, Mzimba, Dedza and Lilongwe Plain.

Although 23.21.0+4S fertilizer was introduced in Malawi for maize production in recognition of S deficiency in Malawi soils, the current area specific fertilizer recommendation will only supply 3, 6 and 8 kg S /ha. The amount of S in the recommended fertilizer was not based on data generated from S research and the country does not know the S status in soils, the optimum rate of S application and the soil S critical level for a maize crop. If the rate of S applied is below the soil critical level or optimum rate, S will limit maize yields in the country. Even the soil database in the Department of Agricultural Research and Technical Services does not provide soil S status in the country. Therefore, there is a need to assess the soil S status in the country, determine the magnitude and location of S deficiency and determine optimum rate of S application for maize production.

Objectives and Methods — The preliminary study covered Lilongwe Agricultural Development Division (LADD) (Figure 3), to assess the incidences of S deficiency before the whole country is covered. The following were the objectives:

1. Assay the S status of soils in Lilongwe ADD and produce Soil S map for LADD
2. Determine S responsive sites in LADD
3. Determine provisional S critical level for maize.

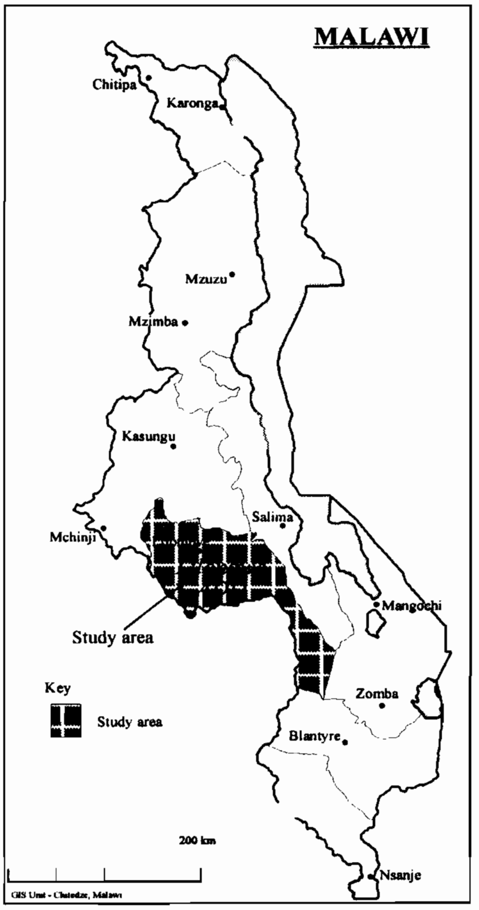


Figure 3. Map of Malawi showing sulphur study area for maize production

Soil sampling was done to cover the whole of LADD. Ten soil samples were collected from each section of the Extension Planning areas. Over 3000 samples are being analyzed for soil pH, organic matter and soil S.

Fifteen-kilogram soil samples were collected from each farmer for greenhouse S response studies. The soil S levels and the relative plant yield % will be used to determine provisional S critical level. The treatments for the greenhouse study were: all plus S and all minus S. "All" included (P, Ca, Mg, Zn, Cu, and N).

Results — The soil analytical data (Table 6) of the already analyzed soil samples show that 66.9% of the sampled sites in Lilongwe West and 52.5 % in Lilongwe East Rural Development Projects are deficient in S. The greenhouse studies have shown several sites have a response to S application. The results show that S deficiency in Lilongwe ADD is second to N in limiting maize production. The results also show variation in soil S status. There are localized areas where S levels are adequate.

Table 6. Summary of soil sulphur status in Lilongwe ADD, Malawi

RDP	EPA	Mean (S ug/g)	% deficiency	pH (water)	Organic matter %
LL/WEST	Chilaza	7.2	76.5	5.1	1.8
	Demela	3.7	85	5.4	1.5
	Ming'ong'o	12.5	49.9	4.9	1.7
	Thawaleka	8	74	4.9	1.2
	Mlomba	11.5	49.3	5.0	1.5
RDP mean		8.6	66.9	5.2	
LL/EAST	Chingonthi	14.2	36.5	5.3	1.8
	Chiwenga	11.3	54.8	5.1	2.0
	Mkwinda	2.51	88	5.2	1.9
	Nyanja	9.8	30.6	5.0	1.5
RDP mean		9.5	52.5		

Liming Equivalence of Organic Materials Used by Smallholder Farmers in Zimbabwe

(Nhamo Nhamo)

Introduction — Soil acidity has been identified as a major constraint to crop production on weakly buffered sandy soils in the Zimbabwean smallholder farming sector. On these granite derived soils, acidity reduces the nutrient use efficiencies and hence the overall crop yields. Low soil pH has been a result of continuous cultivation without addition of lime to check the build-up of acidity. The reduction of soil organic matter leads to lower CEC in the soil and eventual reduction of the bases, leaching also contributes to the pH reduction.

Use of mineral lime has been low among smallholder farmers. Some of the reasons for this are the low appreciation of its importance, inaccessibility, high cost to transporting lime because of its bulkiness and lack of a strong extension message on the use of lime.

Farmers use locally available organic materials as major fertility inputs for crop production. In so doing, the organics supply nutrients and increase soil pH. The extent to which these materials can be used and the mechanism by which they reduce acidity on sandy soils are topics that warrant detailed study. There is high potential to utilize locally available, acceptable and cheap organics as effective alternative liming materials.

The objective of this study is to determine the potential of locally available organic materials to reduce acidity. The liming equivalencies of cattle manure, anthill soil and leaf litter was determined.

Materials and methods — Two sites which had low soil pH were selected on which maize was grown. In the first season (2000/2001) the experiment was replicated at two sites in Murewa, at Chikowore and Fusire.

The liming equivalencies were determined in an experiment that had treatments constituting a lime response curve (0, 300, 600, 900, 1200 kg ha^{-1} lime) and cattle manure, anthill soil and decomposed leaf litter, all applied at 10 t ha^{-1}. A randomized complete block design with three replicates was used in the experiment. Except for the bases, N, P, K and the micronutrients were blanket applied in all the plots. The yield responses were measured and the liming equivalencies of the organic materials calculated.

Results — The two sites where the experiment was conducted had low pH (in $CaCl_2$ solution) values of 3.82 and 3.81 (Table 7). The pH was less than 3.9 at each of three sampling depths. The materials used had high base contents with cattle manures having higher total exchangeable bases than the other materials (Table 8).

The two sites were lime responsive. There was an increase in yields with increasing lime rate. Organic materials also significantly increased yields on both the sites. The yields at Fusire were generally lower than those obtained at Chikowore (Figure 4).

This first season of results showed a positive lime response and the measured liming equivalencies were also positive, ranging from 237 to 555 kg of mineral lime per hectare (Table 8). There was a significant positive linear relationship between the total exchangeable bases and the liming equivalencies of the materials used at both sites (Figure 5).

Discussion — Organic materials cause chemical, physical and biological improvement to the soil. The yield increases following application of organic materials was a result of the combined effect of supplying nutrients, improving the soil physical condition and the liming effects of these organic materials. This helps explain why farmers use organic materials to solve soil fertility problems. However the non-nutrient benefits of these organics have not been quantified.

Table 7. Characteristics of soils from two sites in Murewa, Zimbabwe to a depth of 0.6 m, used to evaluate the liming equivalence of three organic materials

Site	Depth (cm)	pH	K (mg/kg)	Ca (mg/kg)	Mg (mg/kg)	%C
Chikowore	0-15	3.82	31	32	7	0.21
	15-30	3.79	20	31	7	0.19
	30-45	3.82	21	32	8	0.18
	45-60	3.81	24	53	14	0.18
Fusire	0-15	3.81	26	37	6	0.30
	15-30	3.72	14	22	4	0.26
	30-45	3.76	14	14	3	0.23
	45-60	3.75	17	19	4	0.21

The results of the season of application of organic materials used showed positive liming effects from all the materials. Organic amendments add bases to the soil and thus increase the soil pH. Chemical characteristics of the three materials show that they contained high values of total bases (Table 7). The relationship between the liming equivalence and the amount of bases was linear (Figure 5). This shows the importance of the base content to the amelioration of acidity. Work done by others has shown the increase in soil pH following application of cattle manure to sandy soil. In some cases benefits of manure use have been attributed to added bases. Others reported increases in soil pH following the addition of different leaf litter and other organic materials, mainly as a result of the basic cations. In work done on combinations of cattle manure and mineral fertilizers, part of the synergism of this practice has been attributed to non-N effects, including the provision of bases to the soil by the manure. Similar benefits of acid amelioration by wood ash have been reported.

Table 8. Chemical characteristics and the liming equivalencies of cattle manure, decomposed leaf litter and anthill soil calculated from lime response curve from Chikowore and Fusire sites in Murewa in the 2000/2001 season

	Total Exch. Bases (g/kg)	%C	%N	P (g/kg)	pH ($CaCl_2$)	Lime equivalence (kg mineral lime/ha)
Chikowore						
Cattle manure	12.95	16.84	1.05	2.70	6.62	462
Leaf litter	9.90	31.01	1.79	1.23	4.12	291
Anthill	2.32	0.95	*	*	6.33	448
Fusire						
Cattle manure	19.35	29.30	1.20	1.44	6.05	555
Leaf litter	15.30	25.39	0.99	1.23	5.85	379
Anthill	1.97	0.71	*	*	7.27	238

Anthill soil contains high levels of $CaCO_3$ which directly reduce acidity. Studies in Zimbabwe have also shown that most termitaria soils have high clay and soil organic C contents. The soil from the mounds are of high pH; those used in this study had a pH greater than 6.5. Acidity amelioration by organic materials could also be through the chelation of Al ions by organic acid

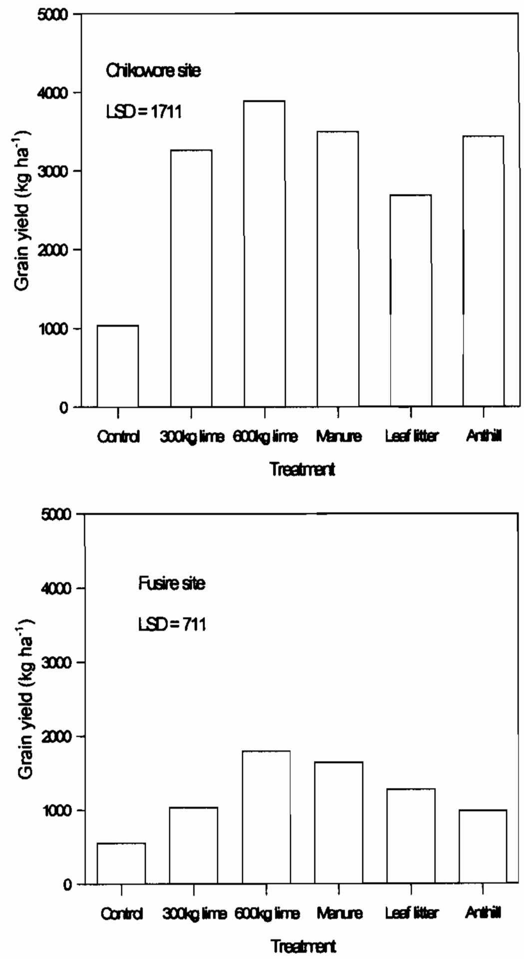


Figure 4. Maize yield responses to application of different organic materials as ameliorants to soil acidity

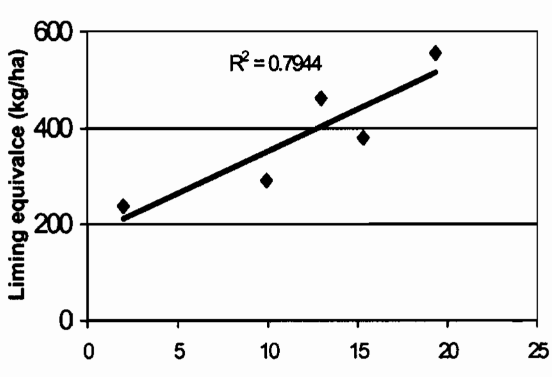


Figure 5. The relationship between the liming equivalencies of cattle manure, leaf litter and anthill soil used in the 2000/2001 season

anions. The process of ammonification in the micro-sites has also been demonstrated to increase soil pH and to some extent reduce overall soil acidity.

Conclusions — Addition of organic materials to acidic soils resulted in significant increase in maize yield. The cattle manure treatment had the highest yield responses compared to others. The liming equivalencies of manure, anthill and decomposed leaf litter were all positive, ranging from 237 to 555 kg mineral lime per hectare. Cattle manure had the highest liming equivalence in the first year of application. There was a linear relationship between the liming equivalencies and the total exchangeable bases in the organic materials.

Whilst the total bases explained most of the variance in the measured liming equivalencies, the chelation of Al by organic anions, and the pH rise following the ammonification processes, remain other possible ways through which acid amelioration is achieved. More work needs to be done on quantifying these effects.

The Response of N Use Efficient Maize to N Fertilizer in Zimbabwe

(Lucia Muza and Stephen Waddington)

Southern Africa Drought and Low Fertility (SADLF) project breeders have developed 'nitrogen use efficient' (NUE) maize genotypes, bred under low soil nitrogen conditions. An experiment was conducted during the 2000-01 season to test the response of these genotypes to several rates of mineral N applied on farmers' fields. The aim was to determine whether the new genotypes offer better returns to the small amounts of expensive N fertilizer that farmers now apply.

Four NUE genotypes (two hybrids and two open pollinated varieties (OPVs)) and a commercially available check hybrid (SC501) were evaluated at 0, 15, 30, 60 and 90 kg ha^{-1} of applied N. The experiment was conducted at six sites in sub-humid and semi-arid zones of Zimbabwe.

Despite considerable variability on farm, there was preliminary evidence that some of these elite NUE maize genotypes can provide more grain with little or no N fertilizer (0-30 kg ha^{-1}) than can the commercially available hybrid SC501. One of the experimental hybrids, CML395/CML312//CML440, out yielded the OPVs and the other hybrids without N fertilizer at all sites except the severely depleted Chihota sites, and almost doubled the yield at Domboshava station (Figure 6). The OPVs were very responsive to fertilizer N over the range to 60 kg N ha^{-1} and they equaled the grain yield of the experimental and check hybrids at four sites. Compared with the check hybrid, SC501, the ex-

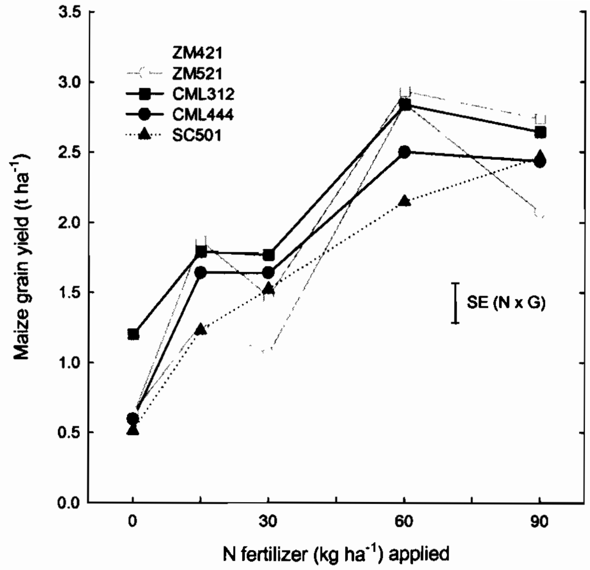


Figure 6. Maize grain yield (t ha^{-1}) of experimental N use efficient maize genotypes across five N rates at Domboshava, Zimbabwe 2000-01

perimental OPVs and hybrids had higher NUEs (often above 50 kg grain per kg N applied) at the 15 and 30 kg N ha^{-1} rates, but SC501 tended to have the higher NUE at 60 to 90 kg N ha^{-1} at the higher yield sites, and particularly in Chinyika.

These preliminary results suggest the experimental hybrids may provide improved returns when grown with little or no fertilizer, compared with genotypes already available. The new OPVs may provide similar returns to the new hybrids when grown with 15-60 kg N ha^{-1}, but with less investment needed to buy seed. More data are required from infertile communal areas fields that are so widespread in Zimbabwe, and so the experiment was planted again in the 2001-02 cropping season.

Factors Affecting the Adoption of Soil Fertility Technologies in Mhondoro, Zimbabwe

(Reneth Mano and E Chawoneka)

Zimbabwe is benefiting from regional networks such as AFNET (funded by the Tropical Soil Biology and Fertility Program, TSBF), others by CIMMYT and ICRISAT, as well as Soil Fert Net. These regional networks promoted the development of low-input soil fertility improving technologies. The technologies include cattle manure and lime application, and fertilizer conditional on rainfall. These technologies were disseminated to the farmers through farmer participatory methods and various communication channels by various initiatives in the regional networks.

Taking into account the magnitude of soil fertility loss, the need to ensure household food security and the large investment made towards development of best-bet technologies, it is expected that farmers would show interest in the soil fertility technologies and subsequently adopt them. However, literature has shown that the adoption of these types of technology has been low, mixed, sporadic and slow. To understand this behaviour by farmers, our research has the following objectives.

Objectives —

- Assess households' degree of awareness and adoption of best-bet soil fertility technologies in Mhondoro, Zimbabwe.
- Investigate the perceptions of households towards the best-bet soil fertility technologies.
- Investigate factors affecting the adoption of soil fertility technologies with particular reference to fertilizer adoption.

Results highlighted the type of households adopting each of the selected soil fertility technologies. This is important for targeting the development and improvement of soil fertility technologies. In addition, various classes of adopters can be identified with their various technology needs. Perceptions by households towards the technologies will also be brought out, informing questions on why farmers exhibit mixed responses on the adoption of selected soil fertility technologies.

Factors affecting technology adoption —
Literature has identified several factors responsible for the behaviour exhibited by households in adoption of technologies. These fall into five major classes, that is, perceived attributes of the technology, farm characteristics, farmer characteristics, input/output market forces and research-extension-farmer linkages.

To ascertain the relative importance of the various factors affecting adoption of selected soil fertility and other soil fertility technologies, a binary logistic model was employed. The model treats adoption as a dichotomous yes/no dependent variable. The multivariate model used has the following assumptions:

The values of Y the dependent variable are independent of one another.
The probability distribution of the dependent variable Y is normal.
The standard deviation of the error term is constant regardless of the values of X_{ni}
The residuals (predicted minus observed values) are distributed normally.

Farmers were divided into two groups; those who apply quantities below 203kg of fertilizer/ total area and those applying quantities above 203kg/total area. The 203kg demarcation represents the geometric mean fertilizer application. Geometric mean has the advantage that it takes into account variations in the data set, thus outliers in the data do not seriously affect it. This demarcation implies that farmers applying fertilizer below 203kg/total area are the low users and those applying above 203kg are regarded as high users of fertilizer. Table 9 shows the results from the analysis of the factors affecting fertilizer adoption. Emphasis is placed on the direction of association between the dependent and the independent variable rather than the significance of regression coefficients. However, inclusion of data from other areas like Murehwa and Serima is likely to enable analysis of factors affecting other technologies.

Fertilizer — The explanatory variables account for 74.3% of the variability in the dependent variable. Fertilizer adoption in both the low and high-level users is more pronounced in households with access to income for purchasing the technology. There is therefore need to reach a certain cash endowment threshold level before taking up the technology. This means access to

Table 9. Logit model results of fertilizer adoption
R Square = 0.743

Variable	Regression coefficient for farmers using > 203 kg/ha	Regression coefficients for farmers using ≤203 kg/ha	Significance level (at 0.05)
Sex	-135.482	162.753	1.000
Farm size	22.021	-22.021	0.998
Per capita income	2.214	2.214	0.997
Education	42.977	-70.248	1.000
Labor supply	36.608	-36.608	0.996
Age	3.069	-3.069	0.998
Farmer organization	169.099	-196.369	1.000
Constant	-995.131	776.943	1.000

cash enables households to be interested in adopting fertilizer.

Households with large pieces of land are in the high level of fertilizer application group. This is so because the technology comes in a ready form and is more compatible with large pieces of land. In addition, fertilizer can be used in combination with other soil fertility technologies enabling coverage of large areas. These reasons explain the emerging contrast with the expectation that since the technology is cash demanding households may not be able to buy enough for large pieces of land. However, this result raises questions about the ability of farmers to adhere to stipulated application rates of the technology, especially if the high price of the technology is considered.

Membership in a farmer organization had a positive influence on the adoption of the technology by those farmers in the high fertilizer use category. This is because farmers benefit from networking and peer pressure aiding the adoption of the technology. However, farmers using less than the geometric mean application rate seem not to be in farmer groups, thus the negative relationship between adoption and membership.

In general regression coefficients on education, membership in a farmer organization, farm size, age and cash endowments indicate that fertilizer use is more popular with market-oriented farmers, who are also the high fertilizer users. These regression coefficients also show that farmers using less than the geometric mean application rates are young and just starting farming and have not yet joined farmer groups.

Popularity of the selected soil fertility technologies — We used the total cropland that is under a given technology as an assessment of its popularity. The general observation is that farmers use various combinations of the best-bet package and they sometimes mix best-bet packages with familiar traditional methods of maintaining soil fertility. A cross tabulation of household type and technology in use revealed common combinations such as fertilizer + cattle manure, fertilizer + termite mound + cattle manure, fertilizer + cattle manure + rotations, termite mound + green manure + compost, fertilizer + cattle manure + compost. Fertilizer is found in combination with best-bet components as well as traditional methods of maintaining soil fertility status. In other cases, a household uses fertilizer as a single technology. Lime is more often used on its own. This may be explained because lime is being substituted for termite mound. Farmers believe these two technologies perform the same function in soil fertility maintenance.

These observations may thus explain the magnitude of percentages of cropland under technologies being studied. However, the degree of popularity of a particular technology has nothing to do with its intensity of use. The results of the cross tabulation are shown in Table 10.

Our findings are that fertilizer and cattle manure are more popular with the farmers (popularity of + 50%). Farmers use these two technologies in most of their technology combinations. Also, fertilizer and cattle manure have traditionally been used by the farmers and initiatives such as the Soil Fertility Network has added to farmer exposure and interest in using these technologies. Farmers have over many years seen the benefits of these technologies because they increase yields.

Thus while some best-bet soil fertility technologies (fertilizer and cattle manure) cover considerable cropland relative to the traditional or other soil fertility technologies, some others (lime and legume cereal rotations) are rarely used. While promotion efforts have been directed to fertilizer and cattle manure at the expense of lime and legume cereal rotations, it is also likely that fertilizer and cattle manure are more compatible and profitable to the farmer, thus the wide popularity.

The major area of concern is the popularity of lime, which recorded less than 12% popularity with the farmers. A lot of investment has been put into the development and dissemination of the technology. One effective way to understand the low popularity of liming is to follow the Rogers innovation decision process. Rogers

Table 10. Total area under technology

Technology	Percentage of farm size covered by the soil fertility technology
Fertiliser*	63.9
Cattle manure*	58.3
Lime*	8.5
Legume-cereal rotation*	34.0
Termite mound	23.4
"Green manure" plough under	36.0

** = Best-bet soil fertility technology* stipulates that individuals follow a common framework in their adoption decisions, starting with awareness, interest and adoption. The study analyzed these stages and produced the results in Table 11.

Table 11. Innovation decision stages

Technology	Percentage of farmers aware of the technology	Percentage of farmers willing to use the technology	Percentage of farmers using the technology
Fertiliser	98.6	97.3	95.6
Cattle manure	98.6	100	82.1
Lime	73.6	80.6	6.5
Cereal-Legume rotations	70.8	100	39.4
Termite mound	90.3	55.9	16.1
"Green manure" plough under	61.1	100	48.5

Generally, Mhondoro farmers are aware of both the best-bet soil fertility technologies and traditional technologies. The channels that were used in information dissemination enabled most farmers to appreciate the existence of the technologies. Fertilizer and cattle manure show a very high response along the innovation decision process where farmers are aware, willing to implement the technologies and finally adopt the technology. However further probing on the reason for such a trend for use of fertilizer revealed that 97% of the farmers use fertilizer because it increases yield and just 2.8% used it because it improves soil fertility. Therefore the popularity and use of fertilizer is more dependent on the economic value that is placed by farmers on the technology. There is still a challenge to ensure that farmers are informed about the contribution of fertilizers to soil fertility improvement. The farmers have over the years seen a change to productivity variables such as yields and costs.

Cattle manure's popularity is because farmers observe that it improves soil fertility. In percentage terms, 50% of the respondents identified cattle manure's contribution to soil fertility as the major reason for its use, where 42.9% was attributed to it improving yield of the crops. The rest of the farmers claimed that it is one of the cheapest technologies to implement.

While most farmers are aware and willing or interested to use the given technologies, there is a wide gap between willingness to adopt the technologies and actual adoption. The gap is more pronounced with lime use. Our study investigated this gap by probing farmers' reasons why they are not using the technologies.

Farmers revealed that, though they appreciate the contribution of lime in rectifying soil acidity, improvement to soil fertility and large contribution to yield increases, there are still major constraints to the effective use of lime. 50% of the farmers said the technology was expensive whilst the remainder lacked knowledge about the technology. Lack of knowledge about lime needs to be tackled by development planners. There is need for more investment in the promotion and dissemination of appropriate information about lime.

The legume cereal rotation is also of concern, since there is a large disparity between interest and use of that technology. Farmers identified their soil type as limiting the success of this technology. The claim is that their soil (*shapa*) is susceptible to waterlogging which forces them to start planting in July so that by late November, the crops would have grown to levels where they can resist the waterlogging. This farming system thus makes the growing of soybean compete with maize, which is the major crop. Despite these drawbacks, farmers appreciate that legume-cereal rotations are important in soil fertility improvements and yield increase.

Termite mound is one technology that has being affected by labour problems. 64.7% of respondents identified termite mound as labour demanding, hence its low use by the farmers. It requires the farmer to dig the mound, transport and spread the technology in the field. Other farmers lamented that termite mounds have become scarce such that looking for them consumes so much time that most households do not use this technology. "Green manure" suffers from resource intensity and lack of space.

Determinants of Adoption of Manure Storage Practices in Murewa, Zimbabwe (Kilian Mutiro, J. Mutihero, E. Chabayanzara and H. K. Murwira)

Introduction — Manure is used by most smallholder farmers in Zimbabwe as a low cost soil fertility management option. Manure contributes about 32% of the total nitrogen used by smallholder farmers in managing soil fertility and inorganic fertilizers contribute about 64%. The use and effectiveness of manure is limited by the small quantities available and the poor quality of the manure. Numerous studies have highlighted that communal area manure is of low quality, containing less than 1 % N. Poor grazing, storage, and handling contribute significantly in reducing the nitrogen content of communal area manure. The traditional method of curing manure on a heap for at least three months before application in the field has been found to result in losses of nitrogen of up to 40%. The quality of the manure is worsened by the availability of too much sand with some manure having as much as 80% sand.

Improving manure management and storage is an important option for improving maize yields and returns to investment. A new manure storage method was developed for smallholder farmers in an effort to reduce losses and improve the quality of manure. The new technology involves curing manure in a covered pit, through anaerobic decomposition. The conventional method of storing manure in the smallholder sector has been to dig out the manure and heap it outside the kraal where it cures, through aerobic decomposition, for at least 3 months. Farmer participatory trials were implemented in Murewa from 1996 to 1998 for farmers to test the technology. Some farmers have already adopted the technology and some are still verifying returns from investing in the technology. This research has analyzed the factors affecting the adoption of the new manure storage technology in Murewa.

Objectives of Study — The study aims at analyzing the factors affecting adoption of the pit storing technology. We seek to characterize farmers who have been adopting the technology to derive lessons for better targeting of the technology and its effective dissemination to farmers.

Data Collection — A household survey was implemented in Murewa. One hundred households were randomly selected, 20 households from each of the five wards in Murewa. Structured questionnaires were used to collect information from farmers. Information was collected on farmer and household characteristics, soil fertility management practices, farm implement ownership, crop production and livestock holding.

Results and Discussion — Most factors were not statistically significant in explaining adoption of the pit storage technology. Only age of household head, number of cattle owned and manure use experience appeared important in explaining adoption of pit storage. Younger households have a higher probability of adopting pit storage technology compared to older farmers. This could be because younger households are more innovative and have a lower aversion to risk. This could also be because younger farmers are more able bodied and are able to cope with the additional labour demands of pit storing manure.

Farmers with large cattle herds have a lower probability of adopting pit storage, perhaps because these farmers are able to compensate the poor quality of their manure with higher rates of application since they have large herds. Those farmers with small herds of cattle are not able to produce large quantities of manure each year and have to rely on producing better quality manure to improve productivity. Farmers with experience of manure use are in a better position to accurately assess the risk and relative returns of pit storing manure compared with heap storage and these are more likely to get higher returns from pitting manure.

Labour availability, household income, extension contact and educational status of the farmer, though not statistically significant, can help us understand the possible impact of these factors on adoption of pit storage technology. The relationship between adoption of pit storage technology and labour availability is negative indicating that families with more labour are not likely to adopt the technology. This is contrary to expectations and indications from farmers. In the survey, farmers were asked to identify important factors determining adoption of manure related technologies and most farmers identified labour availability as an important factor. Income had a negative relationship with adoption of the technology indicating that families with higher income are not likely to adopt pit storing. This is explained by the fact that high-income families can afford mineral fertilizers compared to poor households. Poor households have to rely on technologies in which they substitute cash requirements with their labour. Pit storing offers that opportunity. Extension influence on the adoption of the technology is negative and this implies that pit storing is not part of the messages on soil fertility management being extended to farmers by extension. Farmers are not likely to get information on the pit storage technology from the extension service in Murewa. Farmers with more years of formal education are likely to adopt the technology compared with those with limited formal education.

Conclusion — There may be a need to redefine the target group to effectively disseminate the technology to achieve the desired impact. Poor farmers with smaller herds of cattle can be targeted for greater adoption and impact. Extension provides information to most farmers on new technologies and linking up with extension in Murewa could boost the adoption of the technology. The link up could come through a workshop where findings on the technology are presented.

Measuring the Social Costs of Soil Erosion: Effects on Productivity, Income and Food Security in Malawi (Teddie O Nakhumwa)

Justification for this study — Soil erosion and nutrient mining pose a serious threat to the long-term potential of agricultural production in Malawi. The National Environment Action Plan has singled out soil erosion as first among nine environmental issues in Malawi that require urgent attention.

Quantitative information on economic losses caused by soil erosion and nutrient mining in Malawi is very limited. No information is available on dynamic land rents reflecting on quality of land. Research in Malawi has so far concentrated on soil conservation practices and factors that usually influence adoption of such technologies. This study therefore is trying to measure the dynamic economic costs of soil erosion and soil mining in Malawi. It is envisaged that the results of the study will provide a picture of the country's current consumption rate of its soil wealth, and the implications of that for future generations. The study is attempting to establish a sustainable path of soil nutrient extraction. It is expected that results of this study will provide useful information for adjusting the current system of national accounts for the depletion of soil resources. This will correct the current measures of economic performance (based largely on GDP) and social welfare.

Objectives of the Study — The overall objective of the study is to measure the economic costs of soil erosion in Malawi. The specific objectives are:

- Quantify the effects of soil erosion and nutrient-mining on long-term soil and agricultural productivity;
- Compute dynamic resource rents for soil in Malawi reflecting the scarcity value of depleting soil resource stocks over time;
- Assess whether the prevailing smallholder cropping systems maximize soil wealth;
- Build local capacity for economic and policy analysis of soil fertility issues in Malawi and Southern Africa.

Research Progress — All fieldwork and part of the analysis has been completed. Field research involved soil chemical and physical analyses in two districts, Mangochi and Nkhata Bay. A socio-economic survey was carried out in the same districts. All this work and laboratory analysis on the chemical composition of the soils has been completed. Descriptive analysis on socio-economic characteristics of households in the study areas has also been finalized.

SLEMSA erosion models for the entire country have been run using GIS. Maps have been developed for soil erosion, soil type, rainfall and soil nutrients. These maps cover all the eight Agricultural Development Divisions (ADD).

Secondary data collection has also been concluded and involved information on all major crops and land allocated to each crop per ADD, fertilizer purchases, price data, rainfall time series data, soil nutrient levels for each ADD, focussing on all major nutrients. An economic analysis on soil erosion and computation of nutrient balances remains to be done.

Factors Affecting Adoption of Organic Soil Fertility Technologies in Malawi (Hardwick Tchale and Owen Chamdimba)

Problem Statement — Agriculture is the mainstay of Malawi's economy contributing to 40% GDP, 85-90% of foreign exchange earnings and employs about 85% of the labour force. The smallholder sector produces 80% of total agriculture output. Maize is a staple and most important food crop in Malawi. Productivity of maize has been affected by many factors including low soil fertility and land degradation. Recent policy measures and efforts taken by the government include the Starter-Pack Scheme-1998 and Targeted Input Program-2000. On the research side, Malawian researchers in collaboration with Soil Fert Net partners have been looking for alternative sustainable cost-effective inorganic and organic technologies. The under-sowing of *Tephrosia vogelii* and rotation of *Mucuna pru-*

riens and maize are two best-bet technologies that are recommended and are being used by farmers.

Objectives — This study investigates the socio-economic factors affecting the smallholder farmers' adoption of under-sowing *Tephrosia vogelii* in Lilongwe Agricultural Development Division (LADD), and rotation of *Mucuna pruriens* and maize in Machinga and Blantyre Agricultural Development Divisions (BLADD). The other objective is to assess farmer's perceptions and traditional knowledge of these technologies and how this can be used to influence adoption.

Methodology — Quantitative data has been collected from Ntcheu (120 households) and Zomba (134 households) RDPs. Qualitative data has been collected from BLADD. Secondary data from the MPTF was used at Chitedze Research Station. Data analysis for the adoption of Mucuna is complete while the analysis for Tephrosia is in progress. A total of 240 smallholder farmers were interviewed during the exercise and eight focus group discussions were made. The focus group discussions were stratified according to gender.

Preliminary Impressions — The preliminary findings from the focus group discussions are given below.

Tephrosia study - Tephrosia is locally known as a natural shrub to most of the farmers. The leaves of Tephrosia are used as an insecticide in vegetable gardens. The stems are used as firewood for cooking. Some farmers have sold seed to MAFE (Malawi Agroforestry Extension) at MK10/ kg. This has also been an incentive to those farmers who grew the crop. MAFE uses the seed for redistribution purposes to new farmers. MAFE has been in Ntcheu RDP since 1991 but they limited their operations to a few sections in Njolomole EPA.

Farmers reported that the major constraint to adoption of Tephrosia as a soil fertility enhancing technology is that it does not have a food value. They also perceived that Tephrosia improves soil fertility but they are discouraged because it takes time to realize the benefits. It was also learnt that lack of seed, insufficient technical know how and land pressure still remain a challenge to the promotion of this technology as a soil fertility crop. However they also reported that they think sensitization of farmers to the benefits of the crop, through awareness campaigns can help to improve its adoption.

Mucuna study - Farmers in the southern regions of Malawi have used Mucuna for a very long time and they recycle seed from old stock as planting material. Farmers realize that the crop restores soil fertility and they use the seed for food. It is eaten as a snack or relish. Sometimes the seed is kept after harvest as a food security crop for use when maize runs out. Mucuna was also reported to suppress witchweed. No formal markets exist for the crop but it is sold in local markets and by the roadside.

Farmers perceive that Mucuna improves soil fertility because the crop following Mucuna performs and yields better. However, the main reason for growing it is for food and sale. Common practice is to plant it in maize fields in furrows, usually after banking. The plants are spaced 2-3m apart. This has a direct bearing on the plant population and consequently the amount of biomass and seed produced. The practice is because of land pressure. Some of the constraints the farmers meet in using Mucuna include poor germination because of the recycling of seed, lodging of the main maize crop if you try to increase the plant populations, disruption of other field operations like weeding and harvesting.

There seems to be no adoption of Mucuna as a rotation for soil fertility improvement. However, based on respondents' experience with the crop, there are several potential factors that can affect its adoption as a soil fertility technology. These include technology dissemination channels (e.g. extension, social institutions, leadership positions etc.), assets (e.g. radio, bicycle), gender of household head and land holding size (number of plots of land).

Economics of Growing *Mucuna* as a Green Manure in Malawi (Shephard Siziba, Mulugetta Mekuria and Webster Sakala)

An experiment to measure the maize yield effect of using *Lab lab*, *Mucuna* and *Crotalaria* as alternative legume-based soil fertility interventions was conducted by Chitedze researchers in Central, Southern and Northern Malawi between 1997 and 2000. Findings from this experiment show that *Mucuna* had the highest maize yield effect and it produced the highest amount of biomass (6.5 t/ha). We conducted a financial analysis of those data to assess the incentive for smallholder farmers to adopt *Mucuna* as an alternative soil fertility intervention in Malawi.

Net present values (NPV) were calculated for two green manure interventions and compared to use of inorganic fertilizer (Table 12). For the green manure interventions, NPV compares the cost (forgone maize yields in the investment year) to the benefits (additional maize yield accruing in the subsequent two years after *Mucuna* incorporation).

The findings of this study show that the NPVs for using *Mucuna* alone are positive in Southern and Central Regions of Malawi, while it is negative in the Northern Region. All the treatments had a negative NPV in the Northern Region of Malawi. Combining *Mucuna* and inorganic fertilizer increased the NPV only for Central Malawi while in the Northern and Southern Regions NPV decreased. In all regions except in the north, *Mucuna* alone was less profitable compared with fertilizer alone.

A sensitivity analysis shows that the attractiveness of growing *Mucuna* as a green manure soil fertility intervention responds positively to slight increases in the maize yield effects, converting *Mucuna* seeds for consumption or sale, reducing interest rates and increasing the grain price of maize. Rules of thumb for smallholder farmers that can be derived from this study are: (1) if smallholder farmers do not have adequate capital to buy inorganic fertilizers they are better off investing in *Mucuna* than not in Central and Southern Regions. (2) if they have enough cash, farmers in the Central Malawi alone can combined *Mucuna* with fertilizer to get best returns, (3) farmers in the south get best returns by using fertilizer alone.

The policy implications from this study are: (1) reducing inflation and interest rate will encourage investment in green manures and (2) increasing the grain price of maize will increase profitability of using *Mucuna* as a soil fertility technology in Malawi.

Table 12. Financial analysis of green manuring and inorganic fertilizer use in Malawi

Technology	Regions of Malawi NPV (at 34% discount rate)		
	South	Central	North
Mucuna alone	K 1,645	K 1,824	K -3,398
Mucuna + fertilizer (35:10:0+2S)	K 997	K 4,664	K -4,367
Fertilizer (35:10:0:2S) alone	K 6,268	K 3,356	K -1,226

Payoffs to Green Manuring in Maize Based Communal Areas of Zimbabwe

(Tendai Gatsi, Mulugetta Mekuria and Shephard Siziba)

Green manures were recommended in Zimbabwe (then Rhodesia) in the 1950s to help supply the N needs of maize. Then inorganic fertilizers were not recommended. Increasing availability of cheap inorganic fertilizers after World War II replaced the legume green manure practice. However, with the liberalization of economies in most less developed countries of Sub-Saharan Africa (including Zimbabwe), agricultural input costs (seeds, fertilizers and others) have risen beyond the reach of most communal area farmers. This has resulted in less fertilizer being used by the smallholder sector. In addition, few smallholder farmers have access to cattle manure due to the recurrent droughts in Zimbabwe.

A study to assess the feasibility of different green manuring technologies (velvet bean and sunnhemp) in combination with inorganic fertilizer was conducted during the 1996-98 seasons in two communal areas (Chihota and Zvimba) of Zimbabwe. A financial analysis to identify profitable options of the different treatments is presented below.

The net present value is an absolute measure, and is a more appropriate measure for similar projects and/or cost outlays. If funds are limiting, this measure is useful for comparing mutually exclusive projects. In addition, the benefit cost ratio is also calculated. The benefit-cost ratio is determined by dividing discounted benefits by discounted costs. As a way of dealing with uncertainty, sensitivity analysis was conducted to observe how much the present values and benefit cost ratios would change by changing interest rates.

Results of the financial analysis using a conservative discount rate of 30% show a positive return to investing in velvet bean in addition to 45kg of N, with or without the addition of P (Table 13). Assuming a 2:1 return to investment as an acceptable level for adoption of technologies by smallholders, we identified the top six technologies/treatments. To determine the robustness of the treatments, a sensitivity analysis was conducted. Again, assuming a 2:1 return to investment, the top four treatments showed favourable returns to investment. Therefore green manuring, especially velvet bean, is worth investing in if the biomass is incorporated into the soil rather than removing it.

Changes in maize grain and fertilizer prices and discount rate are important variables in determining the profitability of these soil fertility technologies. This analysis focussed on the changes in the discount rate, which indicates the price changes in the economy. When moving to a higher discount rate of 50%, the relative ranking of the treatments does not change (Table 13). However, as expected, the benefit cost ratios decreased. If the current unrealistic rates (more than 80% interest rate and an inflation rate of 112%) are considered, some of the treatments will not be attractive options anymore. It therefore implies that in terms of policy, a stable macro-economic environment with lower interest rates is crucial in determining the profitability of the technologies whose benefits accrue some years in the future.

Promotion of Soil Fertility Technologies

"Official Release" of Organic Matter Technologies by Malawi

After a thorough review of the technologies by the Agriculture Technology Clearing Committee in Malawi during a meeting held at Chitedze Agricultural Research Station on August 15, 2001, the Ministry of Agriculture and Irrigation in Malawi (through the Department of Agricultural Research as its Secretariat) released three organic matter technologies that can be used to increase soil fertility. The technologies released included the use of three green manures in isolation or in combination with inorganic fertilizers. The green manure species and practices released are the use of *Mucuna pruriens, Crotalaria juncea* and *Lablab purpureus* (L.) Sweet. Plans are being developed to produce leaflets on *Crotalaria juncea* and *Lablab purpureus* (L.) Sweet in the near future.

Additional Best Bet Technologies

The network broadly endorsed four new "Best Bet" technologies during 2001. These are:

- *Tithonia* spp. leaf prunings
- Groundnut + pigeonpea intercrop rotation with maize for Malawi
- *Crotalaria grahamiana* and *C. ochroleuca* green manures
- Anaerobically-composted cattle manure for Zimbabwe.

Private Sector Input Dealer Participation in Promotion of Soil Fertility Technologies

To encourage the participation of agro enterprises in the dissemination of best bet soil fertility technologies in the smallholder farming sector, a project entitled "Promotion of Soil Fertility Technologies through the Private Sector" was developed in 2001 with guidance by Soil Fert Net and has been funded by the Rockefeller Foundation (Figure 7). This regional project involves Zimbabwe, Zambia and Malawi and is an extension of the Agri Business Development Programme (ABDP) being jointly implemented by the African Centre for Fertiliser Development and Africa University with the collaboration of national institutions. The project will work closely with other members of Soil Fert Net.

Some of the soil fertility technologies tested by various projects funded by the Rockefeller Foundation within Soil Fert Net, will be promoted in Zimbabwe smallholder farming areas through this new project.

Table 13. Financial analysis of green manuring under 30% and 50% discount rates

Treatment	PV benefits	PV costs	NPV	B/C ratio	Rank
30% discount rate					
V/v bean (incorporated) + 100P2 +45N	13,360.67	4,054.52	9,306.15	3.30	3
V/v bean (incorporated) + 0P2 +45N	15,619.55	3,302.43	12,317.12	4.73	1
V/v bean (incorporated) + 0P2 + 0N	9,839.21	2,918.18	6,921.02	3.37	2
Sunnhemp (incorporated) + 100P2 +45N	8,801.92	3,821.39	4,980.53	2.30	5
Sunnhemp (incorporated) + 100P2 + 0N	7,219.00	3,486.89	3,732.10	2.07	6
Sunnhemp (biomass removed) + 100P2 +45N	8,190.58	3,197.47	4,993.10	2.56	4
50% discount rate					
Treatment	**PV benefits**	**PV costs**	**NPV**	**B/C ratio**	**Rank**
V/v bean (incorporated) + 100P2 +45N	8,992.15	2,995.95	5,996.20	3.00	3
V/v bean (incorporated) + 0P2 +45N	10,452.55	2,366.26	8,086.30	4.42	1
V/v bean (incorporated) + 0P2 + 0N	6,662.27	2,099.34	4,562.92	3.17	2
Sunnhemp (incorporated) + 100P2 +45N	6,196.20	2,816.03	3,380.17	2.20	5
Sunnhemp (incorporated) + 100P2 + 0N	5,025.33	2,585.49	2,439.83	1.94	6
Sunnhemp (biomass removed) + 100P2 +45N	5,845.21	2,361.91	3,483.30	2.47	4

Figure 7. Private sector promotion of soil fertility technologies

These include lime, gypsum, rhizobium inoculants, phospho compost, efficient use of organic and inorganic fertilizers and the cultivation of legume green manure and rotation crops.

Trained agro dealers located in rural areas are the best source of inputs, crop markets and provision of the technical and marketing information to the farming communities who are their business clients. This new initiative is expected to make a significant contribution on the training and networking of rural agro dealers to enhance their capability and capacity in the transfer of soil fertility technologies within the small holding farming areas of the region.

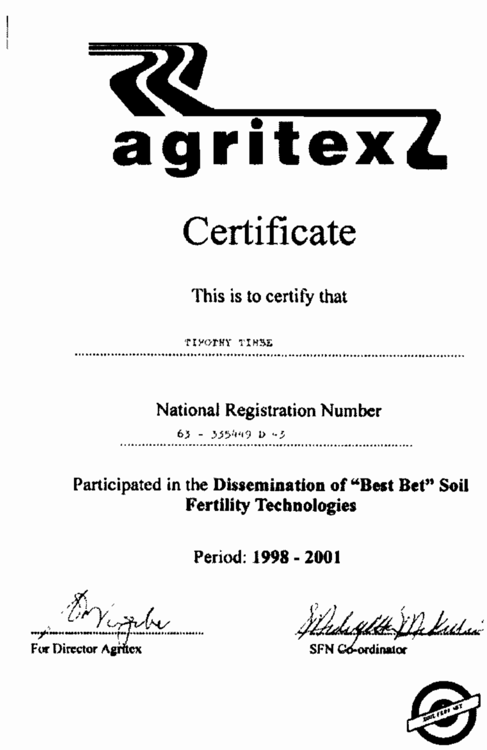
A preparatory workshop was held in Harare on 9 August 2001 to launch the project, identify which technologies should be promoted and where, determine the role of agro-business in promoting each technology, and identify areas of collaboration with related agencies. The highest priority technologies were identified as lime for maize and other field crops, rhizobium inoculant for soyabean, single superphosphate and gypsum for groundnut, and phosphocompost. The project will target agro dealers in 12 communal and resettlement areas in Natural Regions 2-5. The project began in Zimbabwe in 2001. Training will commence in January 2002.

Chihota Soil Fertility Extension Pilot Project

After three and a half years of work, the Chihota Soil Fertility Technology Extension Project led by AGRITEX in Zimbabwe, closed at the end of 2001.

The project exposed almost 4000 farmers to several soil fertility technologies and over 2300 farmers have used one or more of the technologies on their own fields. Some 600 farmers (who have participated throughout the life of the project and continue to use the technology) will receive a certificate in January 2002 (Figure 8).

2000-2001 has been an exceptionally difficult year for most stakeholders in the Chihota Soil Fertility Project, mainly due to changes in the Zimbabwe macro economic environment. Nevertheless, AGRITEX managed to implement many demonstrations with farmer groups participating in the project (Table 14). This season many of the demonstrations were laid out better. Results were affected by poor rainfall distribution.


agritex

Certificate

This is to certify that

National Registration Number

Participated in the **Dissemination of "Best Bet" Soil Fertility Technologies**

Period: **1998 - 2001**

For Director Agritex | SFN Co-ordinator

Figure 8. A Chihota Project farmer certificate

Table 14. List of 2000-01 demonstrations conducted by the Chihota Soil Fertility Extension Project

Technology	Number of Sites Established	Number of Field Days Held
Maize liming	29	15
Rotation	23	12
Green manure	9	4
Herbicide	19	2

Maize liming was the most popular technology, hence the highest number of field days held. Many outside stakeholders did not manage to visit the demo sites. Because of this, AGRITEX collected data on how the field days were held and the outcome of the field days in the form of comments and questions from both the local AGRITEX officers and farmers.

During October, two weeks of feedback sessions from farmer groups to extension and research staff were followed by a successful close down stakeholder meeting at Marondera. AGRITEX staff and farmers attended, along with the Soil Fert Net Coordinators and a representative from the Soil Productivity Research Laboratory. The meeting began with presentations on the main findings with the technologies and then looked at the way ahead.

All agreed that the last three years had been extremely useful. Many farmers had picked up some helpful soil fertility technology, extension staff felt they had been doing something worthwhile, we had all learned a lot about farmer interest in the technologies and about the strengths and weaknesses of the participatory extension methods used in the project. A final project report is being compiled by AGRITEX and baseline survey and input dealer survey reports are almost ready.

Although the project has officially closed, several follow-ups were developed for the 2001-02 season. Extension staff in the project will:

- ▷ continue to give backup advice to farmers and obtain feedbacks on the technologies (especially liming which is popular with farmers),
- ▷ link with the new ACFD input dealer project in the area to train local shopkeepers in the technologies,
- ▷ plant maize for a second year after the green manure demonstrations and measure the yield (to help do some good economics on the green manures), and
- ▷ implement farmer-led seed multiplication gardens for some of the legumes in 2001-02.

Additionally, there was clear interest in doing some follow-up with farmers to characterise those that are using the technologies and to see how they are using and modifying them on their own fields. This attempt to look at the "real adoption" will involve several agricultural economists with support from the SoilFertNet Coordination Unit agricultural economists. We expect modest funds to be available in 2002 from the Soil Fert Net grant to support seed multiplication and the "adoption" assessments.

Networking and Information Exchange

Learning Workshop on the Economic Evaluation of Natural Resources, Soil Fertility and Cropping Systems: Implications for Sustainability and Food Security

The purpose of Soil Fert Net is to facilitate interaction, communication and collaboration between the various disciplines involved in soil fertility research, to foster integrated multidisciplinary work on this important issue. Often, researchers from the different disciplines of agricultural sciences have limited knowledge and exposure to the methods and tools used by other fields of specialty. This is especially true between the socio-economic and natural sciences, where a wide gulf exists. Lack of familiarity with other disciplines in agricultural research hinders the effective integration of the various essential components of a complex farming system.

A realization of this gap by members of the Soil Fert Net Economics and Policy Working Group (EPWG) led to the design of this workshop. The workshop was planned to expose agronomists and soil scientists to methods and tools applied by socio-economic disciplines and *vice versa*.

Participants — A total of 30 agronomists, soil scientists, economists and policy analysts from Soil Fert Net Member Institutions in Malawi, Zimbabwe and Zambia participated, with support from the Network. (Table 15). In addition, four scientists from the Ethiopian Agricultural Research Organization attended, with their own funding.

Objectives — The Natural Resource Economics Learning Workshop had the following major objectives:

- Enhance collaborative research activities between biophysical scientists, economists and policy analysts.
- Review relevant tools and methods in natural resource and environmental economics, spatial analysis-GIS, and crop modelling.
- Share experiences and draw lessons in the applications of the tools mentioned above.
- Have an update of EPWG research activities.

Table 15. Participants that attended the Learning Workshop on Economic Evaluation of Natural Resources and Soil Fertility, Pretoria, South Africa 2-7 April 2001

Name	Discipline	Affiliation
Reneth Mano	Agricultural Economics	Dept. of Agric. Economics and Extension, University of Zimbabwe, Harare
Killian Mutiro	Agricultural Economics	Tropical Soil Biology and Fertility Programme (TSBF), Harare, Zimbabwe
Ephraim Chawoneka	Agricultural Economics	Dept. of Agric. Economics and Extension, University of Zimbabwe, Harare
David Dhliwayo	Soil Science	Soil Productivity Research Lab. DR&SS, Marondera, Zimbabwe
Tendai Gatsi	Agricultural Economics	Agronomy Institute, DR&SS, Harare
Rebecca Zengeni	Soil Science	Soil Science Dept., University of Zimbabwe
Fred Makonese	Soil Science	Soil Science Dept., University of Zimbabwe
Rashid Hassan	Agricultural Economics	University of Pretoria, South Africa
Dean Fairbank	GIS	University of Cape Town, South Africa
Paul Mapfumo	Soil Science	Soil Science Dept., University of Zimbabwe
Crispen Kapunda	Agricultural Economics	Mochipapa Research Station, Choma, Zambia
Petan Hamazakaza		Mochipapa Research Station, Choma, Zambia
Ronald Msoni	Soil Science	Mt. Makulu Research Station, Chilanga, Zambia
Evans Kapekele	Agricultural Economics	Misamfu Research Station, Kasama, Zambia
Moses Mwale	Soil Science	Mt. Makulu Research Station, Chilanga, Zambia
Godfrey Sakala	Soil Science	Mt. Makulu Research Station, Chilanga, Zambia
Tesfaye Zegeye	Agricultural Economics	Ethiopian Agricultural Research Organization (EARO)
Yonas Yemishaw	Forest Policy/ Sociology	National Tree Seed Project, Ethiopia
Legesse Dadi	Agricultural Economics	EARO
Yusuf Assen	Agricultural Economics	EARO
Mariam Mapila	Agricultural Economics	Bunda College of Agriculture, Lilongwe, Malawi
Alex Phiri	Agricultural Economics	Bunda College of Agriculture, Lilongwe, Malawi
Webster Sakala	Agronomy	Chitedze Agricultural Res. Ministry of Agriculture, Malawi
Hardwick Tchale	Agricultural Economics	Bunda College of Agriculture, Lilongwe, Malawi
Teddie Nakhumwa	Agricultural Economics	Bunda College of Agriculture, Lilongwe, Malawi
Amon Kabuli	Agricultural Economics	Bunda College of Agriculture, Lilongwe, Malawi
Owen Chamdimba	Agricultural Economics	Bunda College of Agriculture, Lilongwe, Malawi
Fredrick Msiska	Agricultural Economics	Bunda College of Agriculture, Lilongwe, Malawi
Blessings Botha	Agricultural Economics	Bunda College of Agriculture, Lilongwe, Malawi
Johannes Karigwindi	Agronomy	CIMMYT-Soil Fert Net
Stephen Waddington	Agronomy	CIMMYT-Soil Fert Net
Mulugetta Mekuria	Agricultural Economics	CIMMYT-Soil Fert Net

Resource Persons and Presentations — Presentations by resource persons, discussion of results of findings, practical computer exercises on GIS using ARCView software, group discussions and panel discussion were all employed in this workshop.

Rashid Hassan of the University of Pretoria and Dean Fairbanks of the University of Cape Town were the resource persons for the Natural Resource and Environmental Economics and GIS-Spatial Analysis topics, respectively. Akin Adesina, Rockefeller Foundation's Resident Representative for Southern Africa, gave a very stimulating keynote address on the "African Green Revolution: Challenges and Issues for NRM Research".

Akin Adesina gave a comparative analysis of the Asian Green Revolution and the desired African Green Revolution. The germplasm-led Asian Green Revolution of the 1970s was made possible through efficient research, extension and input delivery systems. The homogenous environment and access to infrastructure that small farmers had were the added advantages. The complex and diverse African agro-ecologies and production systems require a different type of "green revolution". Simplistic policy instruments to get prices right have not brought the expected supply response in African agriculture. Getting the infrastructure right, having equitable markets, developing germplasm that could work under low input and harsh conditions, generating technologies that deal with critical soil fertility problems, consider labour and gender aspects of the rural households and having appropriate policy support to improve smallholder agriculture are suggested vital components of the African Green Revolution. These would shape the directions of the technology growth path as discussed by the speaker.

The SFN Coordinators, Steve Waddington and

Mulugetta Mekuria, provided background information on SFN and EPWG, the workshop objectives and expectations. Scientists from the Agricultural Research Council Institute of Soil, Climate and Water of South Africa gave a briefing on their activities and implications for smallholder agriculture. Zondai Shamudzarira of the CIMMYT Risk Project and Webster Sakala of DARTS Malawi presented findings of crop modelling research activities. Grantees of EPWG projects also updated us on the status of their research activities. Very useful interventions and suggestions were made by participants to improve the quality of the on going research activities.

The following issues were identified for discussion by three working groups:
What have we learnt and the implications for SFN projects?

- How do we incorporate Natural Resource Economics, GIS, Spatial and Modelling tools in our research projects? For what? Examples.
- Measuring short and long term benefits and costs of SFN technologies:

What tools/methods are especially useful? Data requirements?

- What work should be developed on this?
- Priorities? Give country specific criteria
- Who will do what?
- Disciplinary links? Current situation, problems and ways to improve linkages

Incorporation of NRE into existing and new projects

- Farmer participation and assessment in NRM technology generation and transfer: how and at what level?
- Policy: does it matter? Country specific vs. regional policy
  - ⇨ How can these tools help with policy?
  - ⇨ What policy instruments are needed or are missing to support the wide use of NRM technologies by smallholders?
  - ⇨ Mechanisms for linking and informing research and policy.

The three groups presented their feedback reports to the plenary. Incorporation of new tools discussed at the learning workshop was considered potentially useful. Because GIS provides pictorial illustration and integrates different data sets, it is a powerful tool and could be useful to prepare policy briefs. Existing projects need to ensure that they measure short and long-term costs and benefits and micro and macro impacts (including those on the environment). It was also suggested that a new generation of SFN-EPWG projects should integrate socio-economic and bio physical modelling and apply the new tools of GIS and NR accounting to assess policy issues.

Given the very limited capacity in the region, the need for targeted training on GIS-Spatial analysis was identified as critical. In some member countries there is limited capacity (GIS) and on going projects. NR accounting projects in SADC could be used to organize in-country training. Linkages with regional fora such as FANRPAN and MASIP could assist to create the necessary dialogue with policy makers.

The current regional networking and the proposed new management structure for Soil Fert Net have been rated as excellent mechanisms. Country-level coordination of multi-disciplinary activities has to organize review meetings, workshops and field trips. These networking activities require resource commitments (including communication tools) and should be budgeted in the respective project proposals submitted to donors. Assigning specific roles among members of a multi-disciplinary team in a project is very critical to enhance effective collaboration. Strengthening links across relevant stakeholders and institutions, hosting field trials and demonstrations of SFN best bet technologies in selected districts will contribute to scaling up.

Understanding the Adoption and Impact of Soil Fertility Technologies Workshop

This Soil Fert Net EPWG Regional Workshop, held at Juliasdale, Zimbabwe on 3-6 December, 2001, brought together as many as 45 researchers and development personnel, representing five countries and many institutions and disciplines (Table 16).

Zimbabwe had 17 participants from DR&E (DR&SS and AGRITEX) and the University of Zimbabwe, while Malawi had a delegation of 13 from DARTS, Extension, Care International and Bunda College of Agriculture. Five participants came from DRSS-Zambia, three from ICRAF-Zambia and World Vision International-Zambia. We were very pleased to welcome two participants from Mozambique's INIA-National Research Institute. Two scientists from ICRAF-Zimbabwe, three from CIMMYT-Zimbabwe and one from CIMMYT-Kenya also participated in the regional workshop.

Table 16. Participants that attended the Workshop on Understanding the Adoption and Impact of Soil Fertility Technologies, Juliasdale, Zimbabwe 3-6 December 2001

Name	Discipline	Affiliation
Aggrey Agumya	Geographical Information System (GIS)	ICRAF Southern Africa, Harare, Zimbabwe
Manuel Amane	Soil Science	Instituto Nacional De Investigacao Agronomia, Maputo, Mozambique
Olu Ajayi	Agricultural Economics	ICRAF, Chipata, Zambia
Ephraim Chabayanzara	Agricultural Economics	Dept. of Agric. Econ., University of Zimbabwe
Tendai Gatsi	Agricultural Economics	Agronomy Institute, DR&SS, Harare, Zimbabwe
Wellington Chaduka	Agricultural Economics	Dept. of Agric. Econ., University of Zimbabwe
Owen Chamdimba	Agricultural Economics	Bunda College of Agriculture, Lilongwe, Malawi
Ephraim Chawoneka	Agricultural Economics	Dept. of Agric. Econ., University of Zimbabwe
Davison Chikazunga	Agricultural Economics	Soil Productivity Research Lab. DR&SS, Marondera, Zimbabwe
Reneth Mano	Agricultural Economics	Agric. Economics Dept., University of Zimbabwe
Dorothy Chilima	Nutrition	Bunda College of Agriculture, Lilongwe, Malawi
Hugo De Groote	Agricultural Economics	CIMMYT-Kenya
David Dhliwayo	Soil Science	Soil Productivity Research Lab. DR&SS, Marondera, Zimbabwe
Danisile Hikwa	Agronomy	Agronomy Institute, DR&SS, Harare, Zimbabwe
Rita Jera	On Farm Research	ICRAF Southern Africa, Harare, Zimbabwe
Vernon Kabambe	Agronomy	Chitedze Agric. Res. Stn. Ministry of Agriculture, Lilongwe, Malawi
Bernard Kamanga	On Farm Research	CIMMYT-Malawi
Crispen Kapunda	Agricultural Economics	Ministry of Agric., Choma, Zambia
Evans Kapekele	Agricultural Economics	Ministry of Agric. Kasama, Zambia
Helen Kasalu	Agronomy	Misamfu Regional Res. Centre, Kasama, Zambia
Ellias Kuntashula	Agricultural Economics	ICRAF, Agroforestry Project, Chipata, Zambia
James Machikicho	Soil Science	Dept. of Soil Science, University of Zimbabwe
Edmore Mangoti	Agricultural Economics	Dept. of Agric. Econ., University of Zimbabwe
Wezi Grace Mhango	Agronomy	Bunda College of Agriculture, Lilongwe, Malawi
Margaret Mkandawire	Extension	Care International, Lilongwe, Malawi
Clayton Moyo	Extension	AGRITEX, Harare
Sheunesu Mpepereki	Soil Science	Dept. of Soil Science, University of Zimbabwe
Benjamin Mtika	Extension	Karonga Add, Ministry of Agriculture, Karonga, Malawi
John Mutihero	Agricultural economics	Dept. of Agric. Econ., University of Zimbabwe
Johannes Karigwindi	Agronomy	CIMMYT-Soil Fert Net
Stephen Waddington	Agronomy	CIMMYT-Soil Fert Net
Mulugetta Mekuria	Agricultural economics	CIMMYT-Soil Fert Net
Killian Mutiro	Agricultural Economics	Tropical Soil Biology and Fertility Programme, Harare, Zimbabwe
Dorah Mwenye	Extension	Agritex/DR&E, Marondera, Zimbabwe
Andrew Bosco Mvula	Soil Science	Ministry of Agric., Misamfu Regional Res. Centre, Kasama, Zambia
Teddie Nakhumwa	Agricultural Economics	Bunda College of Agriculture, Lilongwe, Malawi
Sella Ngulube	Agricultural Economics	ICRISAT, Lilongwe, Malawi
Michael Nyirenda	Agricultural Economics	Bunda College of Agriculture, Lilongwe, Malawi
Alexander Phiri	Agricultural Economics	Bunda College of Agriculture, Lilongwe, Malawi
Donald Phiri	Extension	World Vision Zambia, Agroforestry Project, Chipata, Zambia
Ishmael Pompi	Agronomy	Dept. of Research & Extension, Harare, Zimbabwe
Lovemore Rugube	Agricultural Economics	Dept. of Agric. Econ. University of Zimbabwe
Webster Sakala	Agronomy	Ministry of Agric. Chitedze Agric. Research, Lilongwe, Malawi
Howard Sigwele	Agricultural Economics	FANRPAN/SADC, Harare, Zimbabwe
Franklin Simtowe	Agricultural Economics	Bunda College of Agriculture, Lilongwe, Malawi
Shephard Siziba	Agricultural Economics	CIMMYT-Zimbabwe
Sesele Sokotela	Soil Science	DR&SS, Mt. Makulu Res. Centre, Chilanga, Zambia
Hardwick Tchale	Agricultural Economics	Bunda College of Agriculture, Lilongwe, Malawi
Alberto Tembe	Soil Science	Instituto Nacional De Investigacao Agronomia, Maputo, Mozambique
Mbuso Nhlope	Agronomy	Malkerns Res. Centre, Ministry of Agriculture, Swaziland

The objectives of this workshop were to:

- ▷ Acquire an understanding on adoption and impact potentials of soil fertility technologies in the network region,
- ▷ Review empirical findings of adoption studies undertaken by EPWG grantees and other partner institutions,
- ▷ Revisit methodologies and approaches used in adoption studies.

Howard K. Sigwele, Coordinator of FANRPAN/SADC gave the Keynote address on *Policy Constraints Affecting Technology Adoption in SADC: FANRPAN's Potential Roles in Linking and Informing Research and Policy Institutions.*

A total of 28 papers were presented during four main sessions of the workshop. Some very good and detailed discussions were held on the main points arising from the presentations. In a fifth Special Session, seven new proposals for 2002 were presented and very useful suggestions were made by participants on the relevance of the proposals and how the individual proposals should be improved. Two new additional proposals from the University of Zimbabwe were submitted straight after the workshop and were discussed at the CIMMYT-Zimbabwe offices by the Network Coordinators, EPWG Conveners and Regional SFN Theme Leaders.

The sessions covered:

- Setting the Scene: Adoption and Potential Impacts of SFM Technologies
- Promotion and Dissemination of SFM Technologies: Experiences and Lessons
- Empirical Findings on Adoption of SFM Technologies
- Revisiting the Methods for Adoption and Impact Studies.

Reviewing EPWG proposals for 2002 — Existing projects and new proposals were discussed and participants raised questions on their relevance to the priorities of SoilFertNet, methodological issues, the capacity to undertake the proposed research, and in some cases concerns on the multidisciplinary nature of the studies. Most of the studies covered the different sets of best bet technologies that are being developed and the extent of their use by farmers. Extension and NGO presentations highlighted the need for better interaction between stakeholders in the technology development and transfer continuum. Farmers' resource base, household characteristics, socio economic variables and other institutional and policy factors inhibiting adoption were reported. Alternative and relevant methods being used were discussed at length.

The following new proposals were presented and discussed:

1. A Socio-Economic Analysis of Smallholder Utilization of Phospho-Compost and Liming Technologies for Soil Fertility Management, by D. Chikazunga

2. Assessment of Pit Farming as a Potential Technology in Sustainable agriculture, by C. Kapunda, Sokotela and others

3. The Socio-Economics of Some Soil Fertility Management Options and their Effects on Maize Production and Productivity in Southern, Northern and Eastern Provinces of Zambia, by C. Kapunda, Sokotela, Hazakaza and others

4. The Role of Technology Attributes, Knowledge and Perceptions in Smallholder Farmer Choice of Sustainable Soil Management Practices in Selected Rural Development Project Areas in Malawi, by M. Nyirenda and others

5. Soil Improving Legumes and their Role in Human and Animal Nutrition, by D.M. Chilima, M.A.R. Phiri, W.D. Sakala and A. Safalaoh

6. Promoting Efficiency on Investments in Soil Fertility Among Maize Farmers in Malawi: A Case of Organic and Inorganic Fertilizers, by F. Simtowe

7. Economic Potential and Promotion of the Use of Lime in Northern Zambia, by E. Kapekele, C. Kapunda, Sokotela, Hazakaza and others
   (because of its relevance and expressed interest, participants from Zimbabwe and Malawi have agreed to join and further develop it as a regional project)

8. Enhancing the Dissemination of Soil Fertility Technologies in Smallholder Agriculture, by Hanyani-Mlambo and others

9. A Socio-Economic Analysis of Erosion and Siltation in the Save Catchment Area of Southeast Zimbabwe, by C. Gwata and I. Nyagumbo.

Several participants mentioned concerns about standardized methodologies. Given that one third of the participants were student researchers being supported by EPWG and Forum the discussions and recommendations were considered very useful to SoilFertNet's regional capacity building effort.

Recommendations and suggestions were made on the proposals. The EPWG conveners are responsible to facilitate the feed back and subsequent submission of the proposals for the Network.

Cross Cutting Issues Discussed —

- ▷ The Workshop participants reiterated that socio economic analysis of SFM technologies is very critical for the further refinement of farmer recommendations and timely feed back of such findings is essential.
- ▷ The collaborative research approach being adopted between socio economists, policy analysts, agronomists and soil scientists should clearly articulate the value added component of each participating researcher/discipline and the resource requirements.
- ▷ The poor link and dialogue between research and policy needs to be looked at and there is an urgent need to develop empirical work to identify critical policy constraints to the adoption of SFM technologies.
- ▷ Some of the adoption and impact studies reported used different methods and focused on the description of adoption patterns or incidences. Not many of the studies measured the intensity of adoption and quantified the relative effects and contributions of adoption determinants. New tools and soft wares have to be employed to achieve the latter.
- ▷ Given the constant depletion and attrition of research personnel at NARS, participants have appealed to the Network coordination office that such workshops dealing with methods and tools need to be scheduled regularly because they will contribute to capacity building and efficient execution of research activities.
- ▷ Most agronomy and soil science proposals need to incorporate specific budget lines to cover impact assessment studies of the envisaged research project.

Integrated Soil Fertility Research Field Tour of Northern Zambia

We continued with two field tours in 2001. The first tour, organized principally by Webster Sakala of DARTS Malawi, concentrated on extension and promotion aspects of soil fertility technologies in central and northern Malawi. Most participants were from extension or NGOs. The second field tour visited northern Zambia to look at the special soil fertility problems encountered there and to map out a research strategy to help address them.

The tour to northern Zambia took place from 3 to 11 March 2001. Twenty eight persons attended from Zambia, Malawi and Zimbabwe (Table 17). On Monday 5 March, the participants gathered in the conference hall at Misamfu Research Centre, Kasama, for briefings from the CARO-Region III, CARO-SWM and the Soil Fertility Network coordinators. This covered the welcome address, the objectives and the mandate of the Soils Team in Zambia. There then followed a presentation on the soils found in Northern Zambia, by Sam Phiri. To finish off the morning, the participants were taken through the soils and seed services laboratories. The afternoon was devoted to visiting the trials being conducted at the station. Trials ranged from soil P, N, liming, soyabean inoculation, to quantification of N fixed by beans and soya. The tour of trials continued on Tuesday. Farming systems demonstrations on sweet potatoes, small grains and groundnut breeding trials, green manuring, agroforestry managed fallows and maize breeding trials were visited. In the afternoon a farm was visited where sunnhemp (*Crotolaria ochroleuca)* was being widely used as a green manure.

On Wednesday the participants were taken to Mungwi District. Demonstrations on inoculation of soyabean and use of green manures were shown near the DACO's offices. Later two farmers were visited, both hosting the soyabean demonstrations on inoculation use. In the afternoon a smallholder coffee out-growers scheme was visited. On Thursday, the tour went further north to Mbala District where green manuring using sunnhemp, and the traditional Chitemene and Fundikila systems were shown to the participants. The participants later visited the Kalambo Falls and the Motomoto museum.

On Friday, during a visit to Kateshi Coffee Estates, the use of sunnhemp and *Arachis pintos* on coffee was demonstrated. The tour came to an end with a seminar presentation from Sam Phiri, followed by a wrap-up session.

Issues that came up during the tour:

- ⇒ Soyabean demonstrations on the benefits of inoculation were important for spreading the message, more-so with the additional information on the utilization of the grain from the legume. The soil fertility benefit from this technology were however not being emphasized. There is need to develop simple instructions in vernacular and illustrations on the use of inoculant. Storage conditions for the inoculant also need to be highlighted.
- ⇒ The effectiveness of the residual P on the legume compared with the direct application of P and other nutrients on the N fixing potential of the legume.
- ⇒ Use of cowpea as a green manure. How feasible is it given that there are other uses to the crop, i.e. use of the grain, leaves for relish and

roots for preparation of a drink.

⇒Use of sunnhemp as a green manure. How practical is it to produce the large amount of biomass required to increase fertility on a depleted soil? On fertile soils it could be used effectively for maintaining the fertility. What is the labour requirement and the economics of using it on other crops? The technology has low adoption, why?

⇒Weeding and management of sunnhemp green manure. Early planting of green manure might not be a priority for smallholder farmers.

⇒Improvement of bean yield and its N fixing potential. Beans are an important part of the diet in Northern Zambia.

⇒Use of bambara groundnut as a legume in the cereal + legume rotations given that it is a good fixer of N.

⇒Fertilization of coffee in Northern Zambia; including the use of inorganic fertilizers and cover crops on coffee.

⇒*Tithonia* use in amelioration of acidity and recycling of nutrients. How can it be used together with other external sources of nutrients? What happens to the quality and quantity of biomass with consecutive pruning? It is important to consider the labour and the potential biomass production as well as how sustainable the technology is.

⇒Use of agroforestry species directly for soil fertility amelioration and through fodder.

⇒Use of improved fallows. Consider direct seeding of legume species into natural grass fallows to improve biomass from these systems.

⇒Lime work; follow up with surveys and appropriate demonstrations.

⇒Plant spacing for maize, beans, and other legumes grown on the soil ridges by farmers.

⇒Farmer perceptions of soil fertility and the new technologies aimed at improving soil fertility.

⇒Research-Extension-Farmer linkages in technology testing and transfer.

Table 17. Participants that attended the Field Tour on Integrated Soil Fertility Research in Northern Zambia, 3-11 March 2001

Name	Discipline	Affiliation
Regis Chikowo	Soil science	Soil Science Dept, University of Zimbabwe
Walter Mupangwa	Soil science	SPRL, Chemistry and Soil Research Institute, DR&SS, Marondera, Zimbabwe
Nhamo Nhamo	Soil science	SPRL, Chemistry and Soil Research Institute, DR&SS, Marondera, Zimbabwe
Dominika Shumba	Extension	AGRITEX, Shurugwi, Zimbabwe
Moses Mwale	Soil science	DR&SS, Mount Makulu, Chilanga, Zambia
Masauso K Sakala	Soil science	DR&SS, Mount Makulu, Chilanga, Zambia
Prospard Gondwe	Soil science	DR&SS, Mount Makulu, Chilanga, Zambia
Mlotha Damaseke	Soil science	DR&SS, Mount Makulu, Chilanga, Zambia
Ronald Msoni	Soil science	DR&SS, Mount Makulu, Chilanga, Zambia
Abraham Ngoliya	Farming Systems	Farming Systems, DR&SS, MAFF, Mansa, Zambia
Shadreck Bwembya	Soil science	DR&SS, Misamfu, Kasama, Zambia
Andrew B. Mvula	Soil science	DR&SS, Misamfu, Kasama, Zambia
Costah Malama	Soil science/ agronomy	DR&SS, Misamfu, Kasama, Zambia
Evans Kapekele	Agricultural economics	DR&SS, Misamfu, Kasama, Zambia
Helen Kasala	Farming Systems	DR&SS, Misamfu, Kasama, Zambia
A. Bunyola	Soil science	CARO Region 3, DR&SS, Misamfu, Kasama, Zambia
Samuel Phiri	Soil science	DR&SS, Misamfu, Kasama, Zambia
Obed Lungu	Soil science	School of Agriculture, Univ. of Zambia, Lusaka, Zambia
Kenneth Munyinda	Soil science	School of Agriculture, Univ. of Zambia, Lusaka, Zambia
Spider Mughogho	Soil science	Bunda College of Agriculture, Univ. of Malawi, Lilongwe
G. Nyandule-Phiri	Extension	Lilongwe ADD, Lilongwe, Malawi
Kempton Chavula	Extension	Director of Crops, Ministry of Agriculture, Lilongwe, Malawi
Webster Sakala	Agronomy	Maize Team, DARTS, Chitedze Research Station, Lilongwe, Malawi
Wezi Mhango	Agronomy	Bunda College of Agriculture, Univ. of Malawi, Lilongwe
Herbert Murwira	Soil science	TSBF, ACFD, Harare, Zimbabwe
Johannes Karigwindi	Agronomy	CIMMYT-Soil Fert Net
Stephen Waddington	Agronomy	CIMMYT-Soil Fert Net
Mulugetta Mekuria	Agricultural economics	CIMMYT-Soil Fert Net

Issues and Observations During the Wrap Up Meeting —

- Residue P utilisation by legumes in fields previously cropped by maize. This option requires promotion with farmers if they apply fertilizers to maize.

- Generally beans are poor N fixers. Scientists should endeavour to find the reasons why this is so and see how fixation could be improved, say by breeding.
- Cowpeas are dual purpose for food and as a green manure. We should do more on soil fertility improvement using cowpeas.
- Tithonia does not add N to the soil which means it is dependant on existing fertility. More work needs to be done, especially on combinations with other organic materials and inorganic sources of nutrients.
- Lime use could benefit a lot of growers, but there is a lack of awareness of its use and benefits. More demonstrations should be carried out especially on farmer's fields.
- Direct seeding of legumes as a way to establish improved fallows for soil fertility improvement should receive more attention to cut down the expenses of raising a nursery.
- Green manures prove effective when substantial amounts of biomass are produced and incorporated. With sunnhemp, timely management such as early planting should be observed. Otherwise the little biomass will not help the subsequent crop.
- Management practices for green manures need further research.
- Linkages among Research-Extension-Farmer needs to be strengthened for easy technology transfer.
- Stakeholder (farmer) training is needed to improve their perception of soil fertility problems and management.
- There is a need to target legumes suitable for the environment instead of handling many species which may not yield the desired results.
- Beans are very important as a food legume crop for the high rainfall regions but it does not seem to be a research priority.
- Socio economic studies are required to gauge the impact of technologies extended.
- There is a need to monitor the soil fertility status of farmer's fields.
- Some station demonstrations and trials were doing poorly compared with those on farmers' fields. Thus the management of station activities requires improvement.
- Multipurpose green manures should be encouraged to solve animal, human and soil fertility needs at one go.
- Soil fertility monitoring may be very expensive, but the use of simple field kits is recommended.
- Collaboration between research and other institutions like UNZA must be strengthened to take advantage of all available human resources.
- Farming systems team needs to be more active in carrying out on-farm demonstrations.
- Soil nutrient recapitalization should also look at P, not just N.
- Research agendas should be prioritised. Researchers should not spread themselves too thinly. Concentrate on a few areas and do them well.
- The Theme Coordinators of Soil Fert Net in the proposed new structure should encourage collaboration (individual, national and regional) to take advantage of similar work elsewhere.
- Use of lime is hampered by cost. The EPWG of the Network should lobby governments and exploit ways to make it affordable.
- Need a strategic plan on lime requirements; what should be done and where. Maybe a Task Force should be set-up to look at lime issues in general.

Field Tour on Available Soil Fertility Practices in Central and Northern Malawi

The Soil Fertility Tour for Malawi took place from 19 to 21 February, 2001. The tour covered sites in Lilongwe, Kasungu and Mzuzu Agricultural Development Divisions (ADD's). The tour objective was to view current and available practices and technologies on soil fertility management in maize-based cropping systems. It also allowed researchers the opportunity to interact with and obtain feedback from farmers and extension workers on the technologies that are being promoted.

The 27 participants (Table 18) on the tour were drawn from the Department of Agricultural Research and Technical Services, Department of Crop Production, all the Agricultural Development Divisions (Crops Officers), University of Malawi (Bunda College of Agriculture), Malawi Agroforestry Extension (MAFE), Concern Universal, Sasakawa Global 2000, and the Risk Project represented CIMMYT.

Practices and technologies that were visited and observed during the tour included:

- Use of green manures for increasing soil fertility in maize-based cropping systems.
- Residue management in a long term maize-pigeonpea intercropping and rotation trial.
- Screening top cross hybrid maize and legumes for Striga control.

- On-farm maize variety demonstrations by Seed Co.
- Effect of Tephrosia undersown with maize on the following maize crop (improved fallow).
- Effects of maize legume systems on Striga emergence and maize growth (rotation).
- Risk Management mother-baby trials.
- Rehabilitation of abandoned farms through natural fallow, mucuna/maize rotations and use of inorganic fertiliser.
- Sasakawa demonstrations with emphasis on improvement of maize production through
  - ⇒Increase in plant population
  - ⇒Timing of fertiliser application
  - ⇒Use of hybrid maize varieties
  - ⇒Management of maize field.
- Effect of phosphorus and sulphur on grain legumes and legume green manure crops, and their residual effects on the subsequent maize crop. Grain legumes used were soybean, groundnut and bambara nut whilst the legume green manure crops were Mucuna, Tephrosia and pigeon pea.
- Effect of cattle kraal rotations on maize yield compared with conventional livestock manure applications (heap and pits) for improved maize yield.

Participants observed that technologies such as mucuna-maize rotation, groundnut-maize rotation, intercropping of maize with pigeon pea and Tephrosia and the Sasakawa technologies have positive results. As a result, a good number of farmers have adopted these technologies.

Table 18. Participants that attended the Field Tour on Available Soil Fertility Practices in Central and Northern Malawi, 19-21 February 2001

Name	Discipline	Affiliation
J.P. Mapemba	Extension/ promotion	Concern Universal, Dedza
Noel E. Nyirenda	Promotion	Sasakawa SG2000, Lilongwe
Maria Andreassen	Promotion	Sasakawa SG2000, Lilongwe
M.F.J. Chisale	Promotion	Sasakawa SG2000, Liwonde
K.M. Chavula	Extension	Ministry of Agriculture, Lilongwe
G. Nyandule-Phiri	Extension	Lilongwe ADD, Lilongwe
B.S.K. Neba	Extension	Lilongwe ADD, Lilongwe
B.D. Manyuka-Banda	Extension	Blantyre ADD, Blantyre
M.H.L. Sande	Extension	Kasungu ADD, Kasungu
A.P. Moyo	Extension	Mzuzu ADD, Mzuzu
Ben Mtika	Extension	Karonga ADD, Karonga
N.J. Kausi	Extension	Ngabu ADD, Ngabu
Webster D. Sakala	Agronomy	Maize Team, DARTS, Chitedze Agric Research Station, Lilongwe
Allan D.C. Chilimba	Soil science	Soils Team, DARTS, Chitedze Agric Research Station, Lilongwe
A.M. Chirembo		DARTS, Chitedze Agric Research Station, Lilongwe
D. Kayira		DARTS, Chitedze Agric Research Station, Lilongwe
I.M. Ligowe		DARTS, Chitedze Agric Research Station, Lilongwe
M.W. Lowole	Soil survey	DARTS, Lilongwe
I. Phiri		DARTS, Lilongwe 3
Wezi Mhango	Agronomy	Bunda College of Agriculture, Univ. of Malawi, Lilongwe
Mariam A.T.J. Mapila		Bunda College of Agriculture, Univ. of Malawi, Lilongwe
Owen Chamdimba		Bunda College of Agriculture, Univ. of Malawi, Lilongwe
H. Nkhuzenje		Bunda College of Agriculture, Univ. of Malawi, Lilongwe
Atusaye Mwalwanda		Bunda College of Agriculture, Univ. of Malawi, Lilongwe
Amon Kabuli	Ag economics	Bunda College of Agriculture, Univ. of Malawi, Lilongwe
Spider Mughogho	Soil science	Bunda College of Agriculture, Univ. of Malawi, Lilongwe
Bernard Kamanga	Participatory agronomy	CIMMYT Risk Project, Chitedze Agric Research Station, Lilongwe

However, participants felt that:

a) Some Sasakawa technologies are labour demanding, for example farmers have to plant and apply fertiliser at the same time.

b) Uncertainty about the availability of mucuna seed since farmers are told to incorporate the crop before seeding.

c) There was minimal involvement of farmers in explaining the technologies and practices throughout the tour.

Gaps —

- Sasakawa should consider supporting intercropping. Relay cropping of beans may work for some areas in the Southern Region.

- Improved fallows: There is need to widen the range of legumes by including prolific cowpea in green manure programs.
- There is need for work on utilisation of mucuna.
- A summary of soil fertility technologies should be made available to stakeholders.
- Experimental designs should always include farmer practice.
- The economics of Sasakawa technologies should be evaluated.

Way Forward —

- Collaboration among soil fertility activities needs to be strengthened.
- Mucuna seed should be multiplied and Maize Productivity Task Force Group One has started multiplying the seed through the ADD's.
- In future, more farmers should be involved in the tour.

Overall, the participants indicated that the tour was well organized and offered a range of alternative technologies for soil fertility for farmers with varying ranges of resources. We thank Webster Sakala of DARTS for organizing such a worthwhile tour.

New Soil Fert Net Website

Our website was developed during mid 2001 and became available online in October.
The website domain is:
www.SoilFertNetSouthernAfrica.org

The following types of information are on the site:

⇨ Objectives and structure of Soil Fert Net
⇨ Research and dissemination activities
⇨ Contact information for key members of Soil Fert Net, and their organizations
⇨ Our products and outputs, including information on Best Bet soil fertility technologies and network publications
⇨ What's New in Soil Fert Net.

Some of our publications are downloadable from the site. The site will be updated periodically and is available for members to post information about their work.

Network Publications

A summary of new publications from Soil Fert Net is in Table 19.

Workshop proceedings —
Integration of Soil Research Activities in Eastern and Southern Africa (eds. C. Palm, A. Bationo and S. Waddington), TSBF and Soil Fert Net. Nairobi and Harare, 48p. These proceedings were developed from the "East Meets South" workshop held in Arusha, Tanzania in May 2001.

Best Bet brochures — We have continued to distribute Best Bet soil fertility technology brochures produced in 1999 and 2000. They remain very useful descriptions of Best Bets for farmer advisors. We are developing plans to produce some new brochures in 2002-03.

Network working paper series — Two Working Papers were produced and distributed this year.

Table 19. Publications Produced by the Soil Fertility Network for Maize-Based Farming Systems in 2001

Series and Number	Title	Author(s)	Date Produced
Newsletters:	Target (Issues 25 to 28)	Compiled by Soil Fert Net Coordinator. Open to contributions from all	January, April, July and October 2001
Working Papers: Research Results Working Paper 7	The potential of green manures to increase soil fertility and maize yields in Malawi	Webster Sakala, John Kumwenda, Alex Saka and Vernon Kabambe	May 2001
Methods Working Paper 5	Experiences with farmer participatory mother-baby trials and watershed management improve to soil fertility options in Malawi	Bernard Kamanga, George Kanyama-Phiri and Sieglinde Snapp	February 2001
Workshop Report:	Integration of Soil Research Activities in Eastern and Southern Africa	Cheryl Palm, Andre Bationo and Stephen Waddington (Eds).	October 2001
Annual Report:	Soil Fert Net annual report for 2000	Soil Fert Net coordinators	November 2000

Methods Working Paper 5 on *Experiences with Farmer Participatory Mother-Baby Trials and Watershed Management to Improve Soil Fertility Options in Malawi* by Kamanga, BCG, GY Kanyama-Phiri and S Snapp, was distributed in February and March. It documents experience with farmer participatory methods used to assess soil fertility technologies in Malawi. A short-term "Mother-Baby" trial approach to testing soil fertility options with farmer groups for incorporation onto their fields is contrasted with a medium term "Watershed level" strategy to deploying and testing soil fertility technologies in spatial niches on a community of farms.

This methodology has been adapted for the participatory evaluation of drought tolerant maize within the SADLF project and is now used in several Southern Africa countries.

Research Results Working Paper 7 on *The Potential of Green Manures to Increase Soil Fertility and Maize Yields in Malawi,* by Webster D. Sakala, John D.T. Kumwenda, Alex R. Saka and Vernon H. Kabambe summarizes recent research on this topic in Malawi. The work is now being conducted more widely by extension and research in central Malawi to better assess benefits on farms. Around 300 copies have been produced and distributed, mainly in Malawi.

Participatory Research Methods for Technology Evaluation: A Manual for Scientists Working with Farmers, by Mauricio Bellon of CIMMYT Mexico was produced in 2001. This publication uses experiences from the Chihota Soil Fertility Extension Project in Zimbabwe as one of its prime examples. Limited copies have been distributed.

Powerpoint slide sets — The Coordinators developed Powerpoint slide sets on Soil Fert Net, on Best Bet Soil Fertility Technologies and on Technology Promotion during 2001. These have been used for several presentations and are available to members.

Publication purchases for members — Ten copies of "Managing Soil Fertility in the Tropics: A Resource Guide for Participatory Learning and Action Research" by Toon Defoer and Arnoud Budelman (eds) 2000. KIT, The Netherlands, were purchased by Soil Fert Net and distributed to members mid 2001. The Resource Guide includes a textbook, a collection of cases that explore field experiences with participatory learning and action research, a set of 'all-weather' Field Tools on laminated cards, a CD-ROM that includes a software package to assist in analyzing data, and a manual with detailed versions of the Field Tools plus a User's Guide to the software.

Twenty copies of "*Nitrogen Fixation in Tropical Cropping Systems*, 2nd edition", by Ken Giller and published by CABI were purchased by Soil Fert Net and distributed to members in October.

External Conferences and Workshops Attended by the Coordinators

These included:

- CIMMYT Project Meetings, 19-28 March, Texcoco, Mexico (SRW gave presentation on achievements in Regional Project 1).
- CGIAR Eastern and Southern Africa Integration Workshop, 18-21 September, ICRAF, Nairobi, Kenya (SRW).
- The CGIAR in SSA; CGIAR Mid-Term Meetings, 20-22 May, Durban, South Africa (SRW and MM).
- IMPALA Project, 18-19 June, Lake Chivero, Zimbabwe (SRW).
- MWIRNET 2 Project Development Stakeholder Meeting, 29-31 August, Gaborone, Botswana (MM and SRW).
- Workshop on "Integrated Natural Resource Management", 30 July-1 August, ICRISAT, Matopos, Zimbabwe (SRW).
- CIMMYT Regional Project 1 (Food and Sustainable Livelihoods for Sub-Saharan Africa) Review and Planning Meeting, 13-15 August, Harare, Zimbabwe (SRW and MM. SRW gave presentation and written report on achievements in Regional Project 1).
- CIMMYT Global Project 9, "Conservation Agriculture", Planning Meeting, 18-20 October, CIMMYT, Texcoco, Mexico (SRW).
- Rockefeller Foundation Soil Fertility Research Reviews, 1. Zimbabwe 29 October-2 November; 2. Malawi 5-7 November (SRW and MM).

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

Network-Related Papers with a Contribution from the Coordinators

Hassan, R., M. Mekuria and W. Mwangi (2001). Maize breeding research in eastern and southern Africa: Current status and impacts of past investments made by the public and private sectors, 1966-97. Mexico, D.F.:CIMMYT.

Mekuria, M. and S.R. Waddington (2002). Initiatives to Encourage Farmer Adoption of Soil Fertility Technologies for Maize-Based Cropping Systems in Southern Africa. In: (C. Barrett, F. Place and A. Aboud eds.). "Understanding Adoption Processes for Natural Resources Management for Sustainable Agricultural Production in Sub-Saharan Africa", Wallingford, UK:CAB International. Forthcoming.

Mekuria, M., T. Gatsi and T. Pfumayaramba (2001). A preliminary assessment of the performance, adoption and economics of hybrid, open pollinated and recycled maize production in Chihota and Zimuto districts of Zimbabwe. Harare, Zimbabwe:CIMMYT. Forthcoming.

Palm, C., A. Bationo and S. Waddington (2001). Integration of soil research activities in eastern and southern Africa. TSBF, Nairobi, Kenya and SoilFertNet, Harare, Zimbabwe. 48 p.

Waddington, S.R. and J. Karigwindi (2001). Productivity and profitability of maize + groundnut rotations compared with continuous maize on smallholder farms in Zimbabwe. *Experimental Agriculture* 37:83-98.

Presentations —

Friesen, D., S.R. Waddington and A.O. Diallo (2001). Breeding and Agronomic Approaches to Managing Abiotic Stresses in Maize. Given at the Second Ethiopian National Maize Workshop, EARO, 12-16 November 2001, Nazret, Ethiopia.

Waddington, S.R. and D. Friesen (2001). Conservation Agriculture and Smallholder Maize Systems in Eastern and Southern Africa. Given at CIMMYT Global Project 9, "Conservation Agriculture", Planning Meeting, 18-20 October, CIMMYT, Texcoco, Mexico.

Waddington, S.R. and M. Mekuria (2001). Best Bet Soil Fertility Technologies For Maize-Based Smallholder Farming Systems in Zimbabwe and Malawi. Given at the Rockefeller Foundation Soil Fertility Research Review, 29 October-2 November 2001, Harare, Zimbabwe.

Waddington, S.R. and M. Mekuria (2001). Soil Fertility Management and Policy Network for Maize-Based Cropping Systems in Southern Africa. Given at the Rockefeller Foundation Soil Fertility Research Review, 29 October-2 November 2001, Harare, Zimbabwe.

At the request of authors, the coordinators continued to review drafts of many publications by Network members, including conference papers and journal articles.

The following CIMMYT-Zimbabwe staff are supported under the Rockefeller Foundation Soil Fertility Network grant:

Stephen R Waddington, Maize Agronomist
Mulugetta Mekuria, Agricultural Economist (50% time)
Shephard Siziba, Economics Research Associate
Johannes Karigwindi, Research Assistant
John Chifamba, Recorder/Field Assistant
Rudo Shongedza, Secretary (50% time)
Nothando Moyo, Secretary (50% time)

Acknowledgement — The coordinators would like to thank the many members of Soil Fert Net that have contributed much of the information used in this report.

SRW and MM, Harare, 18 February 2002

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