TSBF Institute

Annual Report 2002

Centro Internacional de Agricultura Tropical
International Center for Tropical Agriculture

VOLUME 1

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5. Output 1: Biophysical and socioeconomic constraints to integrated soil fertility management (ISFM) identified and knowledge on soil processes improved (1477 kb)

Papers

- BNF: A key input to integrated soil fertility management in the tropics. CIAT-TSBF Working Group on BNF-CP……………………………………………………………... 42
- Implications of local soil knowledge for integrated soil fertility management in Latin America. E.Barrios and M.T. Trejo. Geoderma, Special Issue on Ethnopedology (in press) ……………………………………………………… ……………………….. 67
- Decomposition and nutrient release by green manures in a tropical hillside agroecosystem. J. G. Cobo, E. Barrios, D. C. L. Kass and R.J. Thomas . Plant and Soil 240: 331-342, 2002. ………………………………………………………………… 81
- Nitrogen mineralization and crop uptake from surface-applied leaves of green manure species on a tropical volcanic-ash soil. J.G. Cobo, E. Barrios, D.C.L. Kass and R.J. Thomas. Biol. Fert. Soils (2002) 36(2): 87-92……………………………… 96
- Plant growth, mycorrhizal association, nutrient uptake and phosphorus dynamics in a volcanic-ash soil in Colombia as affected by the establishment of *Tithonia diversifolia*. S. Phiri, I.M. Rao, E. Barrios, and B.R. Singh. Journal of Sustainable Agriculture (in press)…………………………………………………………………… 105
- Characterization of the phenomenon of soil crusting and sealing in the Andean Hillsides of Colombia: Physical and Chemical constraints. C. Thierfelder, E. Amézquita, R.J. Thomas and K. Stahr. Paper presented to the 12th ISCO Conference, Beijing, China, May 26-31, 2002 ………………………………………… 117
- Increasing understanding of local ecological knowledge and strengthening interactions with formal science strengthened. J.J. Ramisch and M. Misiko. Report for IDRC 'Folk Ecology' Project……………………………………………………… 123
- "The role of indigenous knowledge in the management of soil fertility among smallholder farmers of Emuhaya division, Vihiga district." *Nelson Juma Otwoma, Student Thesis (submission by end 2003).*………………………………………… 127
- Identification of local plants as indicators of soil quality in the Eastern African region. Somoni Franklin Mairura. *Student Thesis (submission by 2004)*……………. 129
- Evaluation of current ISFM options by participatory and formal economic methods. JJ Ramisch and I Ekise (2002). ……………………………………………………….. 130

- The Competitiveness of Agroforestry-based and other Soil Fertility Enhancement Technologies for Smallholder Food Production in Western Kenya. Julius Mumo Maithya *(Student Thesis, submission in early 2003)*………………………………….. 132
- Assessment of adoption potential of soil fertility improvement technologies in Chuka Division, Meru South, Kenya. Ruth Kangai Adiel. *(Student Thesis, submission by 2004)* ……………………………………………………………………………..……... 133
- Integrated soil fertility management: evidence on adoption and impact in African smallholder agriculture. F. Place, C.B. Barrett, H. A de Freeman, J.J. Ramisch, B.Vanlauwe. *Submitted to Food Policy*…………………… 134
- Finding common ground for social and natural science in an interdisciplinary research organisation – the TSBF experience". J.J. Ramisch (TSBF-CIAT), M.T. Misiko (TSBF-CIAT), S.E. Carter (IDRC, Canada). …………………………………. 148
- Modelling nitrogen mineralization from organic sources: representing quality aspects by varying C:N ratios of sub-pools. M E Probert, R J Delve, S K Kimani and J P Dimes.……………………………………………………………………………… 160
- Dynamics of charge bearing soil organic matter fractions in highly weathered soils; World Congress of Soil Science, Bangkok, Thailand, CD-ROM. K. Oorts, R. Merckx, B. Vanlauwe, N. Sanginga and J. Diels; 2002……………….……………… 174
- Fertility status of soils of the derived savanna and northern guinea savanna and response to major plant nutrients, as influenced by soil type and land use management; *Nutrient Cycling in Agroecosystems* 62, 139-150. B Vanlauwe, J Diels, O Lyasse, K Aihou, E N O Iwuafor, N Sanginga, R Merckx and J Deckers; 2002. 183
- Root distribution of *Senna siamea* grown on a series of soils representative for the derived savanna zone in Togo, West Africa; *Agroforestry Systems* 54, 1-12. B Vanlauwe, F K Akinnifesi, B K Tossah, O Lyasse, N Sanginga, and R. Merckx; 2002……………………………………………………………………………….. 201
- Economics of heap and pit storage of cattle manure for maize production in Zimbabwe. H.K. Murwira and T.L. Kudya *Tropical Science, 42: 153-156*………… 218
- Pathways Towards Integration of Legumes into the Farming Systems of East African Highlands. T. Amede. *(Draft Paper)*………………………………………….. 221
- Towards Addressing Land Degradation in Ethiopian Highlands: Opportunities and Challenges. T. Amede *(Draft Paper)*………………………………………….. 230
- Phosphorus use efficiency as related to sources of P fertilizers, rainfall, soil and crop management in the West African Semi-Arid Tropics. Bationo A., and K. Anand Kumar. ………………………………………………………………………… 237

6. Output 2: Improved soil management practices developed and disseminated.
(**Part 1**, 1639 kb; **Part 2**, 494 kb)

Papers
- Use of deep-rooted tropical pastures to build-up an arable layer through improved soil properties of an Oxisol in the Eastern Plains (Llanos Orientales) of Colombia. E. Amézquita, R.J. Thomas, I.M. Rao, D.L. Molina and P. Hoyos. *Agriculture, Ecosystems & Environment (in press)*…………………………………………… 255
- Sustainability of Crop Rotation and Ley Pasture Systems on the Acid-Soil Savannas of South America. E. Amézquita, D.K. Friesen, M. Rivera, I.M. Rao, E. Barrios, J.J. Jiménez, T. Decaëns and R.J. Thomas. Paper presented at the 17th World Congress of Soil Science, Bangkok, Thailand, 14-21, August 2002: Comission: 1…………….. 264
- Fallow management for soil fertility recovery in tropical Andean agroecosystems in Colombia. E. Barrios , J.G. Cobo, I.M. Rao, R.J. Thomas, E.Amézquita, J.J. Jiménez. *Agriculture, Ecosystems and Environment (in review)* …………………… 273
- Sequential phosphorus extraction of a ^{33}P-labeled oxisol under contrasting agricultural systems. 2002. S. Buehler, A. Oberson, I.M. Rao, E. Frossard and D.K. Friesen. *Soil Science Society of America Journal* 66: 868-877 ……….................... 288

- Constructing an arable layer through chisel tillage and agropastoral systems in tropical savanna soils of the Llanos of Colombia. S. Phiri, E. Amézquita, I.M. Rao, and B.R. Singh. *Journal of Sustainable Agriculture* (in press) ……………………… 306
- Networks of Agricultural Information Dissemination in Emuhaya, Western Kenya. Michael Misiko (TSBF-CIAT), J.J. Ramisch (TSBF-CIAT) and Leunita Muruli (University of Nairobi). *Submitted to the IIED.*…………………………………….. 323
- Decision Support Systems for Integrated Soil Fertility Management. J.J. Ramisch and M. Misiko. *Draft paper*……………………………………………………….. 336
- *Mucuna pruriens* and *Canavalia ensiformis* legume cover crops: Sole crop productivity, nutrient balance, farmer evaluation and management implications. Delve, R.J. and Jama, B. ………………………………………………………… 339
- Farmer participatory evaluation of legume cover crop and biomass transfer technologies for soil fertility improvement using farmer criteria, preference ranking and logit regression analysis. Nyende, P. and Delve, R. J…………………………… 349
- Evaluation of cowpea and Lablab dual-purpose legumes. R. Delve and P. Nyende *(Draft paper)* ……………………………………………………………….. 360
- Mineral nitrogen contribution of Crotalaria grahamiana and Mucuna pruriens short-term fallows in eastern Uganda. Tumuhairwe, J.B., B. Jama, and R. Delve , M.C. Rwakaikara-Silver (2002). *(Submitted to African Crop Science Journal)*………….. 363
- The effect of green manures, Mucuna, Lablab, Canavalia and Crotalaria on soil fertility and productivity in Tororo District, Uganda. Matthew Kuule. *(MSc. Thesis)*.. 364
- Financial benefits of Crotalaria grahamiana and Mucuna pruriens short-duration fallow in eastern Uganda. Tumuhairwe, J.B., B. Jama, and R. Delve, M.C. Rwakaikara-Silver. (Draft paper to be submitted to Journal of Agricultural Economics or African Crop Science Journal) …………………………………….. 365
- Impacts of land management options in western Kenya and eastern Uganda. Delve, R. J. and Ramisch, J. J. (Synthesis paper presented at Regional Workshop)………… 367
- Contending with Complexity: The Role of Evaluation in successful INRM. B. Douthwaite, R. Delve, J. Ekboir and S. Twomlow. Presented at INRM Workshop, 2002……………………………… …………………………………….. 371
- Organic resource management in sub-Saharan Africa: validation of a residue quality-driven decision support system; Agonomie; In Press. B. Vanlauwe, C.A. Palm, H.K. Murwira and R, Merckx; 2002. *Agronomie (in press)*……… …… 396
- Using decision guides on manure use to bridge the gap between researchers and farmers. H.K. Murwira, K. Mutiro and P. Chivenge. *Agriculture & Human Values (submitted)* ……………………………………………………………………….. 410
- Efficacy of soil organic matter fractionation methods for soils of different texture under similar management. P. Chivenge, H.K. Murwira and Ken E. Giller. *Draft*. 418
- Nitrogen mineralization from aerobically and anaerobically treated cattle manures. J. K. Nzuma and H. K. Murwira. *Draft* ………………………………………………. 426
- Influence of tillage management practices on organic carbon distribution in particle size fractions of a chromic luvisol and an areni-gleyic luvisol in Zimbabwe. P.P. Chivenge, H.K. Murwira and K.E. Giller. *Draft* …………………………………….. 434
- Towards addressing land degradation in Ethiopian Highlands: Opportunities and Challenges. T. Amede. *Draft.*……… ………………………………………….. 444
- Soil fertility management for sustainable land use in the West African Sudano-Sahelian zone. A Bationo, U. Mokwunye, P.L.G. Vlek, S. Koala and B.I. Shapiro. *(AfNet 8 Proceedings: In Press)* …………………………………………………… 451
- Soil Fertility Management and Cowpea Production in the Semi-Arid Tropics of West Africa. Bationo, A., B.R. Ntare, S. Tarawali and R. Tabo. *(World Cowpea Conference IITA: In press)* ………………………………………………………. 483

- Sustainable intensification of crop livestock systems through manure management in Western and Eastern Africa: lessons learned and emerging research opportunities. Bationo, A., Nandwa, S.M., Kinyangi, J.M.; Bado, B.V.; Lompo, F.; Kimani, S.; Kihanda, F. and S. Koala. *Draft* …………………………………………………… 522

7. Output 3: Ecosystem services enhanced through ISFM (705 kb)

Papers

- Carbon and nutrient accumulation in secondary forests regenerating from degraded pastures in central Amazônia, Brazil. T.R. Feldpausch, M.A. Rondón, E.C.M. Fernandes, S.J. Riha and E. Wandelli. *Journal of Ecological Applications (in press)* 546
- Slash-and-char – a feasible alternative for soil fertility management in the central Amazon? J. Lehmann, J.Pereira da Silva Jr, M.A. Rondon, M. da Silva Cravo, J. Greenwood, T. Nehls, C. Steiner, and B. Glaser. *Proceedings Chinese Soil Science Society Meeting 2002* …………………… 563
- Effects of Land Use Change in the Llanos of Colombia on Fluxes of Methane and Nitrous Oxide, and on Radiative Forcing of the Atmosphere. M.A. Rondón, J.M. Duxbury and R.J. Thomas. *Agriculture, Ecosystems and Environment (in review)*….. 573
- Carbon Storage in Soils from Degraded Pastures and Agroforestry Systems in Central Amazônia: The role of charcoal. M.A. Rondon, E.C.M. Fernandes, R. Lima, E. Wandelli. *Proceedings LBA Meeting, Manaus, 2002* ……… ……………………… 597
- Biodiversity and ecosystem services in agricultural landscapes – are we asking the right questions? M.J. Swift, A-M.N. Izac[2] and M. van Noordwijk. *Agriculture, Ecosystems and Environment (accepted for publication)*…………………………….. 601

8. Output 4: Research and training capacity of stakeholders enhanced (125 kb)

- Integration of local soil knowledge for improved soil management strategies. E. Barrios, Delve R.J., Trejo M.T. and Thomas R.J. 17th World Congress of Soil Science, Bangkok, Thailand - August 2002. Symposium: 31 …… … 625
- The African Network for Soil Biology and Fertility (AfNet). A. Bationo. …………... 634
- Soil fertility Management in Africa: A Regional Perspective. M.P. Gichuru, A.Bationo, H.C. Goma, S.K. Kimani, P.L. Mafongoya, D.N. Nugendi, H.M. Murwira, S.M. Nandwa, P. Nyathi, M.J. Swift. *African Academy of Sciences (in press)*…………….. 641
- List of Acronyms………………………………………………………………… 648

TSBF Institute Description

Objective: To develop and disseminate to clients strategic principles, concepts, methods and management options for protecting and improving the health and fertility of soils through manipulation of biological processes and the efficient use of soil, water and nutrient resources in tropical agroecosystems.

Outputs: 1) Biophysical and socioeconomic constraints to integrated soil fertility management (ISFM) identified and knowledge on soil processes improved, 2) Improved soil management practices developed and disseminated, 3) Ecosystem services enhanced through ISFM and 4) Research and training capacity of stakeholders enhanced.

Gains: Guidelines for selecting productive and resource-use-efficient crop and forage components. Guidelines for identifying profitable options to manage organic and mineral inputs, crop residues, and green manure, and for controlling erosion and improving soil structure. Site-specific guidelines for optimum management of combined use of inorganic and organic resources. Soil-quality indicators to assist farmers and extension workers in assessing soil health. Decision-support systems for resource conservation and productivity enhancement. Strengthened capacity of NARS by use of decision guides for integrated soil fertility management.

Milestones:

2003 Decision-making tools available for managing soil erosion, nutrient cycling and maintenance of an arable layer. Correlations established between local soil quality indicators and scientific measurements.

2004 Innovations for establishing an arable layer available. Soil management strategies to improve soil structure available for hillsides. Indicators of soil fertility, biological health, and physical quality used for decision making in hillsides and savanna agroecosystems.

2005 A soil quality monitoring system developed and tested by partners. Decision making tool available for combined management of organic and inorganic resources. List of soil quality indicators available to NARS to monitor land degradation. Farmers adopting improved system components, including crops and soil management technologies.

Users: Principally small-scale crop-livestock farmers and extension workers in tropical agroecosystems of sub-Saharan Africa, Latin America and south-east Asia

Collaborators: NARS: CORPOICA (Colombia), DICTA (Honduras), EMBRAPA (Brazil), IAR (Nigeria), IER (Mali), INERA (Burkina Faso), INRAB (Benin), INRAN (Niger), INTA (Nicaragua), ITRA (Togo), KARI (Kenya), NARO (Uganda), SRI (Ghana); AROs: CIP, IFDC, ICRAF, IITA, ICRISAT, IRD (France), ETH (Switzerland), JIRCAS (Japan); Universities: Kenyatta (Kenya), Makerere (Uganda), Nacional (Colombia), Nairobi (Kenya), Sokoine (Tanzania), UNA (Nicaragua), UNA and Zamorano (Honduras), Uberlandia (Brasil), Zimbabwe (Zimbabwe), Leuven (Belgium), Paris (France), Bayreuth and Hohenheim (Germany), SLU (Sweden), AUN (Norway), Cornell (USA), Ohio State (USA).

CGIAR system linkages: Enhancement & Breeding (10%); Crop Production Systems (20%); Protecting the Environment (40%); Saving Biodiversity (10%); Strengthening NARS (20%). Convener of Systemwide Program on Soil, Water & Nutrient Management (SWNM), and contributes to the Ecoregional Program for Tropical Latin America, the African Highlands Initiative and the Alternatives to Slash and Burn Programme.

CIAT project linkages: Integrated soil fertility and soil pest&disease management (IP-1, PE-1), acid-soil adapted components received and adaptive attributes identified for compatibility in systems (IP-1 to IP-5), strategies to mitigate soil degradation (PE-3, PE-4, PE-6), agroenterprise alternatives to improve profitability of soil management options (SN-1), and strengthening NARS via participation (SN-3).

Log Frame Work Plan for the TSBF Institute

Area: Natural Resources
Director: Michael J. Swift

Narrative Summary	Measurable Indicators	Means of Verification	Important Assumptions
Goal Empowering farmers to conduct sustainable agroecosystem management by increasing capacity for integrated soil fertility management through the generation and sharing of knowledge and tools across multiple scales.	• Yields in farmers fields increased. • Land degradation halted/reduced. • Yields per unit area and input increased. • Land use changed	• Farmers surveys. • Regional/national production statistics. • Land use surveys (satellite imagery, rapid rural appraisal).	• Land survey data available • Farmers adopt new technologies • Socioeconomic conditions are favorable for achieving impact • Adequate resources available for soils research
Purpose To develop and disseminate to clients strategic principles, concepts, methods and management options for protecting and improving the health and fertility of soils through manipulation of biological processes and the efficient use of soil, water and nutrient resources in tropical agroecosystems.	• Technologies for soil improvement/ management developed. • Limiting soil-plant-water processes identified. • Compatible plant components identified for low fertility soils in crop-livestock systems. • Guidelines, manuals and training materials for integrated soil fertility management produced.	• Scientific publications • Soil and crop management guidelines published • Decision support systems developed • Annual reports	• Economic analysis of options available • Effective linkages within CIAT and partners in S.S.Africa, LA and S.E. Asia • Socio-economic inputs available from other projects (e.g., PE-3, BP-1) • Field sites accessible
Output 1. Biophysical and socioeconomic constraints to integrated soil fertility management (ISFM) identified and knowledge on soil processes improved.	• Soil, water, nutrient and knowledge constraints to sustainable production defined, and the understanding of the role of soil biota, multipurpose germplasm, and organic and inorganic resources for sustainable management of land resources improved.	• Annual Report/ publications • Reviews published • Documents of synthesized results • Detailed tables published in Annual Report. • Decision guides for ISFM developed.	• Sufficient operational funds for soil and plant analyses. • Literature on constraints available • Farmers continue to participate. • Projects SN-2, PE-3 and PE-4 actively participate. • Collaboration of participatory research project (SN-3), RII and NARS.
Output 2. Improved soil management practices developed and disseminated:	• Relevant knowledge, methods and decision tools for improved soil management to combat soil degradation, increase agricultural productivity and maintain soil health provided to land users in the tropics.	• Annual reports/ publications. • Management guidelines and decision trees published and available to farmers, NARs, NGOs. • Training manual for use with tools. • Maps published. • Simulation models used to assess alternative management of organic resources for ISFM • A policy brief for ISFM produced.	• Sufficient operational funds available for chemical analyses. • Continuity of long-term experiments. • Modeling expertise available from partners e.g. Michigan State Univ. USA, IFPRI, CSIRO. • Soil biology expertise from IRD/Univ. of Paris available.

Narrative Summary	**Measurable Indicators**	**Means of Verification**	**Important Assumptions**
Output 3. Ecosystem services enhanced through ISFM:	• The soil's capacity to provide ecosystem services (global warming potential, water quality and supply, erosion control, nutrient cycling) and maintain soil biodiversity in the face of global change in land use and climate enhanced.	• Annual reports/ publications. • Internationally accepted standard methods for characterization and evaluation of below-ground biodiversity (BGBD), including set of indicators for BGBD loss agreed (GEF funded special Project). • Methods for assessing impacts of land management on soil microbial and faunal diversity tested • Workplan developed to evaluate interactions between soil management practices and soil-borne pests and beneficial organisms.	• Collaboration from partners. • Information from questionnaires synthesized comparisons made with available PE-3 results. • Collaboration with PE-3 on soil erosion in CA. • Collaboration with SN-2, PE-4, PE-3 and SWNM Program. • Collaboration with PE-4 on land quality indicators at reference sites.
Output 4. Research and training capacity of stakeholders enhanced**:**	• Research and training capacity of stakeholders in the tropics in the fields of soil biology, fertility and tropical agroecosystem management enhanced through the dissemination of principles, concepts, methods and tools.	• Scientific information (theses, publications, workshop reports, project documents) disseminated to network members and all stakeholders • Network trials planned and implemented with partners • Degree-oriented and on-the-job personnel trained (Farmer, NARS, NGO's)	• Continued interest/participation of NARS and ARO partners, and national and international universities. • Continued support for collaborative activities e.g. systemwide SWNM program.

EXECUTIVE SUMMARY

3.1 List of Staff

A. TSBF Institute Africa Programme

Senior Staff:
Director: Mike Swift (Soil biology)
Bernard Vanlauwe (Nutrient Cycling Management)
Andre Bationo (AfNet Coordinator)
Herbert Murwira (Soil Scientist)

Senior Research Fellows:
Robert Delve (Soil Fertility Management)
Joshua Ramisch (Anthropologist)
Tilahun Amede (African Highlands Initiative)

Consultants:
Prof Nancy Karanja (BGBD Project)
Dr Stephen Nandwa (SWNM Project)

Research Assistants:
Catherine Gachengo – Kenya
James Kinyangi – Kenya
Isaac Ekise – Kenya
John Mukalama – Kenya
Michael Misiko - Kenya
Joseph Kimetu - Kenya
Paul Nyende - Uganda
Killian Mutiro – Zimbabwe
Pauline Chivenge – Zimbabwe

Technical Staff:
Wilson Ngului,(Laboratory Technician)
Benson Muli (Laboratory Assistant)
Margaret Muthoni (Assistant Lab. Attendant
Francis Njenga (Manual Worker)

Administration Staff:
Charles Ngutu (Finance/Administration Officer)
Alice Kareri (Personal Assistant to Director)
Juliet Ogola (AfNet Secretary)
Caleb Mulogoli (Assistant Account / I.T. Assistant)
Henry Agalo (Driver / Field Assistant)
Elly Akuro (Driver / Field Assistant)

B. TSBF Institute Latin America Programme

Senior Staff:
Project Manager: Edmundo Barrios (Soil Ecology)
Edgar Amézquita (Soil Physics)
Miguel Ayarza (Agronomy) MIS Coordinator (SWNM) - Honduras
Idupulapati M. Rao (Plant Nutrition)

Senior Research Fellow
Marco Rondón (C sequestration/GH gases)

Postdoctoral Fellows
Axel Schmidt (Soil Fertility/Forages)
Erik Sindhoj (Landscape/Soil Fertility)

Consultants:
Myles Fisher (Climate change)
Phanor Hoyos (Crop-livestock systems)
Eloina Mesa (Biometrics)

Research Associates
Neuza Asakawa

Research Assistants
Gonzalo Borrero
Luis Fernando Chávez
Irlanda Isabel Corrales (Carimagua)
Juan Guillermo Cobo
Diego Luis Molina (Villavicencio)
Gloria Isabel Ocampo
Jenny Quintero
Jaumer Ricaurte
Mariela Rivera
Gloria Marcela Rodríguez
Helena Velasquez
Juan Andrés Ramírez
Katherine Tehelen
Marco Tulio Trejo (Honduras)

Specialists:
Jesús Hernando Galvis
Edilfonso Melo
José Arnulfo Rodríguez

Secretaries:
Carmen Cervantes de Tchira
Cielo Núñez P.

Technicians:
Arvey Alvarez
Pedro Herrera H. (Villavicencio)
Jarden Molina

Martín Otero
Maryori Rodríguez
Gonzalo Rojas (Villavicencio)
Gloria Constanza Romero
Hernán Mina
Amparo Sánchez
Flaminio Toro (Villavicencio)
Carlos Arturo Trujillo (Cauca)

Workers:
Nixon Bethancourt (Carimagua)
Joaquin Cayapú (Cauca)
Dayro Franco (Cauca)
Adolfo Messu
Jaime Romero
Josefa Salamanca
Luis Soto
Héctor Julio Unda (Carimagua)

3.2 Linkage with institutions in the region and advanced research organizations

A. TSBF Institute Africa Programme

AROs:
CDR, Denmark: Esbern Fris-Hassen
Centro Nacional de Pesquisa de Soja (CNPSO), Brazil: George Brown
CSIRO-APSRU, Australia: Merv Probert
FAO, Rome
Foundation for Advanced Studies in International Development (FASID, Tokyo).
IDRC, Canada: Guy Bessette
IDRC, Kenya: Luis Navarro
IFDC, Togo: Constant Dangbenon, M.Wopereis, A.Mando
Instituto de Ecologia, A.C., Mexico: Isabelle Barois, Dan Bennack, Carlos Fragoso
International Center for Insect Physiology and Ecology (ICIPE), Nairobi, Kenya
IRD, University of Paris: Patrick Lavelle
World Bank: Beverely Macyntree

Universities:
Alemaya University, Alemaya, Ethiopia
Amadou Bello University, Zaria, Nigeria: E. Iwuafor
Catholic University of Leuven (K.U.Leuven), Leuven, Belgium
Cornell University, Ithaca, USA
Egerton University, Tegemeo Institute, Kenya
Exeter University, UK: Jo Anderson
University of Reading
Jawaharlal Nehru University, India: KG Saxena
Kenyatta University: Daniel Mugendi, Ruth Kangai, Monicah Mucheru and James Kinyua
Makerere University, Uganda: Mary Okwakol, Mary Silver
Mekelle University, Ethiopia;
Sokoine University of Agriculture: Susan Ikerra
Université de Cocody: Yao Tano
Université Federal de Lavras, Brasil: Fatima Moreira
University Lampung, Indonesia: FX Susilo, Muhajir Utomo
University of Abidjan-Cocody, Côte d'Ivoire: Y. Tano,
University of Agricultural Sciences: DJ Bagyaraj
University of Nairobi: Leonita Muruli, Isaac Nyamongo, Lydia Kimenye, Richard Mibey
University of Reading: Geoff Warren
University of Zambia
University of Zimbabwe: Paul Mapfumo and Florence Mtambanengwe
Wageningen Agricultural University, Wageningen, The Netherlands
Cornell University: Chris Barrett
University of London, Queens Mary College, UK: David Bignell

CGIAR Centers
CIMMYT, Kenya: Hugo de Groote
CIP, Kenya: Charles Crissman
ICRAF, Kenya: Frank Place, Steve Franzel, Noordin Qureish, Bashir Jama
ICRISAT, Kenya: Ade Freeman
ICRISAT, Mali: Tabo
ICRISAT, Niger: Aboudoulaye, Abdoulaye and Mahamane

ICRISAT, Zimbabwe: John Dimes
IITA Research Station, Ibadan, Nigeria- Abdou
ILRI, Kenya: Patti Kristjanson, Steve Staal, Philip Thornton, Mario Herrero, Dannie Romney

NARES:
ARS, Chilanga, Zambia: Moses Mwale,
Agricultural Policy Research Unit of Bunda College, Malawi
AHI-Ethiopia: Tilahun Amede
AHI-Tanzania: Jeremiah Mowo, Juma Wickama
Areka Research Centre, Ethiopia
Awassa College of Agriculture, Awassa, Ethiopia
Chidetze, Malawi: Webster Sekala
CRRA Niono, Mali: M. Bagoyoko
DR&SS, Zimbabwe: Nhamo Nhamo, Tarasai Mubonderi
Ethiopian Agricultural Research Organization (EARO), Addis, Ethiopia
Holeta Research Center, Holeta, Ethiopia
INERA, Burkina Faso: V. Bado
Institut National de Recherche Agronomique (INRA), Togo- B.K. Tossah
Institut National des Recherches Agricoles du Benin (INRAB), Cotonou, Benin
Institut Togolais de Recherche Agronimique (ITRA), Lome, Togo
Institute for Agricultural Research (IAR), Zaria, Nigeria: E. Iwuafor
KARI-Embu: Alfred Micheni, Francis Kihanda
KARI-Kakamega, Kenya: Rueben Otsyula, David Mbakaya, Martin Odendo
KARI-Muguga, Kenya: Stephen Kimani
KARI-NARL: Nairobi: Stephen Nandwa
KEFRI, Kenya
Ministry of Agricultural and Livestock Development (MoALD), Kenya
Ministry of Agriculture, Kenya, Ethiopia, Malawi and Uganda
Ministry of Health, Israel: Dorit Kaluski
NARO, Uganda: John Byalebeka
NSS, Mlingano, Tanga, Tanzania: Susan Ikerra and Atanasio Marandu,
Salien Agricultural Research Institute, Lushoto, Tanzania
Soil Research Institute, Kwadaso, Kumasi, Ghana: E. Yeboah

Non-Governmental Organizations:
Africa 2000 Network (A2N), Uganda
Africare, Zimbabwe
AREX, Zimbabwe: W.Mpangwa, J.Nzuma
AT (Uganda)
Bunda College of Agriculture, Malawi
CARITAS, Uganda
CNFA
DARTS, Malawi: W.Sakala
DR&SS, Zambia: M.Mwale
Farmer Groups in Vihiga, Siaya, Busia, Teso, and Kakamega districts of western Kenya and Meru South district of central Kenya, Tororo and Mayuge districts of Uganda; farmer groups in Lushoto (Tanzania), Togo and Benin.
Forestry Research Institute (FORI), Uganda
FOSEM, Uganda
KWAP (Kenya Woodfuel and Agroforestry Project)
PLAN International, Uganda

SDARMP, Zimbabwe: D.Saunders
SG2000 Agriculture Programme, Uganda
Smallholder Flodplain Development Project, Malawi: J. Chisenga
System-wide Livestock Program (SLP)

B. TSBF Institute Latin America Programme

NARS:
CORPOICA – Bogotá, Colombia: Juan Jaramillo
CORPOICA – Bucaramanga, Colombia: Hernando Méndez
CORPOICA – Espinal (Tolima), Colombia: Pedro Pablo Herrera
CORPOICA– La Libertad (Villavicencio), Colombia: A. Rincón, J.J. Rivera, C.J. Escobar, Jaime H. Bernal, Diego Aristizábal, José E. Baquero, Emilio García, Rubén Valencia, Carmen R. Salamanca
CORPOICA – Macagual, Colombia: Carlos Julio Escobar
CORPOICA – Medellín, Colombia: Alvaro Tamayo
CORPOICA – Obonuco (Pasto), Colombia: Luis F. Campuzano, Bernardo García
CORPOICA – Palmira, Colombia: Jorge Peña, Gloria Ortiz, Carlos Arturo Rincón, Ferney Salazar
CORPOICA – Tibaitatá, Colombia: Inés Toro, Margarita Ramírez
CORPOICA – Turipaná (Montería), Colombia: Nora Jiménez, Sony Reza, Socorro Cajas, Carlos Sánchez, Joaquín García
DICTA – Directory of Science and Technology, Honduras.
EMBRAPA– Agrobiologia, Brazil. Bob Boddey, Avilio Franco.
INTA – National Institute for Agricultural Technology, Nicaragua. Elbenes Vega, Lilliam Pavón.
MAG-FOR– Ministry of Forestry and Agriculture, Nicaragua. Eduardo Marín.

Non-Governmental Organizations:
ASOGRANDE, Caicedonia, Colombia: Roberto Tiznes Mejía
CARTON DE COLOMBIA, Cali: Bayron Orrego
CENICAFE, Chinchina: Horacio Rivera, Siavash Sadeghian, Alveiro Salamanca
CENIPALMA, Bogotá: Fernando Munévar, Pedro León Gómez
CETEC: Kornelia Klaus, Aníbal Patiño
CIPASLA, Pescador: Rodrigo Vivas
CIPAV: Enrique Murgueitio, María Cristina Amézquita, Maria Elena Gómez
COLCIENCIAS, Bogotá: Oscar Duarte, Jaime Jiménez
CORPOTUNIA: William Cifuentes
COSMOAGRO, Palmira: Antonio López
CRC (Corporación Regional del Cauca), Popayán: Jesús A. Chávez
CVC (Corporación del Valle del Cauca), Cali: Eduardo Varela, Enrique A. Torres, Alvaro Calero
FEDEARROZ, Ibagué: Alvaro Salive, Armando Castilla
IPF (Instituto de Fósforo y Potasio), Ecuador: José Espinosa
MONOMEROS COLOMBO-VENEZOLANOS, Bogotá: Ricardo Guerrero, Alberto Osorno
PALMAS DE CASANARE, Villavicencio: Juliana Betancourt
SERTEDESO, Honduras: Saúl San Martín

Specialized Institutions:
IFDC, USA; D. Friesen
FAO, Honduras, L.A.Welchez
College on Soil Physics, Trieste, Italy: Miroslav Kutilek
ETH, Zurich, Switzerland; Prof. E. Frossard, A. Oberson
FAO-Lempira Sur, Honduras: Luis A. Welchez
IGAC (Instituto Geográfico Agustín Codazzi), Bogotá-Colombia: Dimas Malagón

IIAP (Instituto de Investigaciones Ambientales del Pacífico), Quibó (Chocó), Colombia: Eduardo García Vega, Luis Carlos Pardo Locarno, Jesús Eduardo Arrollo Valencia
IICA, Bogotá-Colombia: Fabio Bermúdez
IRD, Bondy, France: P. Lavelle
Sociedad Colombiana de la Ciencia del Suelo-SCCS, Bogotá-Colombia: Francisco Silva Mojica
USDA-ARS – Jornada, New México, USA: Jeff Herrick

Universities:
Agricultural University of Norway, Norway: B.R. Singh
CATIE, Costa Rica: John Beer, Muhammad Ibrahim, Francisco Jiménez, Bryan Finegan
Cornell University: John Duxbury, Erick Fernandes, Johannes Lehmann, Janice Thies
CURLA – Unversity for the Atlantic Region, Honduras: Manuel López.
Escuela Agrícola Panamericana Zamorano, Honduras: Carlos Gauge
ESNACIFOR (National School of Forestry), Honduras: Samuel Rivera.
Instituto de Educación Técnica Profesional, Roldanillo, Colombia: José A. Rodríguez, Gustavo A. Ramírez, Alma L. Obregón
Instituto Técnico Agropecuario-ITA, Buga, Colombia: Manuel Amaya Navarro
North Carolina State University, USA: Jot Smyth
Ohio State University, USA. Rattan Lal
Swedish Agricultural University, Uppsala: Olof Andren
University of Bayreuth, Germany: Wolfgang Wilcke.
Universidad de Caldas, Colombia: Franco Obando, William Chavarriaga
University of California-Davis, United States: Donald Nielsen
Universidad Centro Americana (UCA), Nicaragua: Alfredo Grijalva
Universidad Distrital de Bogotá, Colombia: Miguel Cadena
Universidad Central de Venezuela (UCV): Deyanira Lobo
Universidad de los Andes, Mérida, Venezuela: Lina Sarmiento, Dimas Acevedo
Universidad de la Amazonía, Colombia: Bertha Ramírez
University of Chile: M. Pinto
Universidad de Córdoba, Montería, Colombia: Iván Darío Bustamante
Universidad de Costa Rica: Alfredo Alvarado
University of Freiburg; E. Wellmann
University of Ghent, Belgium: Donald M.Gabriels
University of Gottingen, Germany, N. Claassen
University of Hohenheim, Germany: R. Schulze-Kraft, D. Leihner, K. Stahr
Universidad de Lleida, Spain: Idelfonso Pla-Sentis
Universidad de Nariño, Colombia: Hugo Ruíz, Jesús A. Castillo, Germán Arteaga, Javier García.
Universidad del Pacífico, Colombia: Carlos Castilla, Alfredo León, Arnulfo Gómez-Carabalí
University of Paris, France: Patrick Lavelle
Université de Rouen, Rouen, France: Thibaud Decaëns
Universita di Trieste, Italy: Giancarlo Ghirardi
Universidade de Uberlandia, Brazil:
Universidad del Valle, Colombia: Patricia Chacón, James Montoya, Martha Páez
Universidad Javeriana, Bogotá, Colombia: Amanda Varela
Universidad Jorge Tadeo Lozano, Bogotá, Colombia: Abdón Cortez
Universidad Nacional de Agricultura (UNA), Honduras: José T. Reyes
Universidad Nacional Agraria (UNA), Nicaragua: Matilde Somarriba
Universidade de Sao Paulo, Brazil: Klaus Reichardt
Universidad Tecnológica de los Llanos: Jorge Muñoz, Gabriel Romero, Obed García, Julio C.Moreno
Universidad Tecnológica de Pereira: Alex Feijoo
Wageningen University, The Netherlands: Ken Giller, Peter Buurman.

3.3 Financial Resources

Complementary and Special Projects

Research activities reported have been supported from a number of donors

TSBF Institute Africa Programme

List of Current TSBF Projects

Donor / Project	Duration	Total Pledge (US$)
The Rockefellefer Foundation Soil Biology and ecology as a component of integrated soils management in African farming systems	**2002 - 2004**	1,200,000
The Rockefellefer Foundation Collaborative Initiative on Soil Biology for African Agriculture: Exploration of Methods for the Integrated Management of the Soil Biota	**1999 - 2002**	100,000
The Rockefellefer Foundation Collaborative research with the Department of Agricultural Economics and Extension, University of Zimbabwe on the economics of using animal manure for soil fertility management by poor farmers in resettled communal lands of Zimbabwe	**2000 - 2003**	32,034
The Rockefellefer Foundation Expansion of TSBF AfNet acitivities to address the problem of soil nutrient depletion facing smallholder farmers in West Africa	**2002 - 2004**	181,000
The Rockefellefer Foundation Soil fertility improvement technologies in the Tororo district of Eastern Uganda	**2001 - 2002**	41,000
The Rockefellefer Foundation Support for Scientists from East and southern Africa to attend a conference on African soil fertility degradation at Bellagio Study and Conference Centre, March 2002	**2002**	9,000

Donor / Project	Duration	Total Pledge (US$)
IFAD via IFDC Development of sustainable intergrated soil fertility management strategies for smallholder farmers in Sub-saharan Africa	**2001 - 2004**	559,193
Systemwide Livestock Project: SLP/ILRI Improving Crop-Livestock Farming Systems in the Dry Savanna of West and Central Africa.	**2001 - 2002**	29,900
United Nations University Publication and Printing of TSBF Book entitled: "Fighting Poverty in Sub-Saharan Africa: The Multiple Roles of Legumes in Integrated Soil Fertility Management"	**2001 - 2002**	20,000
DANIDA - UNESCO Managing Soil Biodiversity for improved ecosystem services	**2002 - 2003**	43,500
BMZ/CGIAR/CIAT: Soil Water Nutrient Management	**2002**	29,126
GEF via UNEP Conservation and Sustainable Management of Below Ground Biodiversity, Phase I	**2002- 2007**	5,300,000
DfID via CIAT Integrated Resource Management in Crop-Livestock Farming Systems of Sub-Saharan Africa	**2001 - 2004**	£ 421,620
IDRC - Nairobi Community-Based Interactive Farmers Learning Processes and their Application on Soil Fertility Management (Kenya)	**2001 - 2004**	334,940
Food and Agriculture Organization of the UN Soil Productivity Improvement - Farmer Field School Programme (SPI-FFS) in East and southern Africa	**2002**	12,240
Technical Centre for Agricultural and Rural Co-operation Production and Printing of "Soil Fertility Management in Africa: A Regional Perspective"	**2002**	22,979

TSBF Institute Latin America Programme

List of donors of Complementary and Special Projects:

Donor/Project	Duration	Total Pledge (US$)
ACIAR Integrated nutrient management in tropical cropping systems: Improved capabilities in modelling and recommendations.	1999 - 2002	434,130
BMZ-GTZ, Bonn, Germany An integrated approach for genetic improvement of aluminium resistance of crops on low-fertility acid soils	2001 - 2003	690,244 (Euros)
DFID, United Kingdom Integrated Resource Management in Crop-Livestock Farming Systems of Sub-Saharan Africa.	2000-2003	602,916
European Commission (EC), Brussel, Belgium Characterization of South American genotypes of bean for optimal use of light under abiotic stress	2001-2004	831,261 (Euros)
PRONATTA, Colombia Strategies for building up productive arable layer in Altillanura soils/	2001-2004	153,000

3.4 Main highlights of research progress in 2002

Output 1. Biophysical and socioeconomic constraints to integrated soil fertility management (ISFM) identified and knowledge on soil processes improved

- Relationships of organic input quality to fertilizer equivalency values established
- Quantification of lignin and polyphenols in different organic materials
- Nutrient monitoring (NUTMON) approaches introduced at two sites in West Africa
- Optimum management for combined use of organic and inorganic resources established
- Green manures and grain legumes do not work everywhere but there are niches where they could do well on-farm.
- Grain legumes have a much higher likelihood for adoption by farmers due to their multiple benefits and often high profit margins.
- High legume biomass and the consequent high amounts of N incorporated in soil do not always translate to high cereal crop yields because the soil systems are leaky though this can be minimised by manipulating timing of incorporation of the green manures.
- Building on previous progress the modelling work this year involved revising the APSIM SoilN and MANURE modules so that the three fpools that comprise FOM can have different C:N ratios.
- Similarly, following the work in Year 2 a similar approach was taken for the release of plant available P from organic inputs, so that P release depends on the pools having different C:P ratios. In Year 3 changes were also made to the APSIM SoilP and Maize modules to modify the uptake of P and its partitioning within the crop.
- A linked soil-crop simulation model, ruminant livestock simulation model, household model and linear program module developed
- Farm level crop-livestock integration scenarios in four countries developed
- Extension of the preliminary dataset testing fertilizer equivalency value – organic resource quality relationships with data from the AfNet 2001 meeting and West Africa revealed that the original hypothesis put forward by Palm et al. (2001) are valid; the N fertilizer equivalency values were found to be linearly related to the N content of the organic resources for resources with a N content above 2.4% and the slope of the relationship between both characteristics was substantially lower for materials containing a large amount of soluble polyhenols.
- Resource flow maps, drawn in various sites across East Africa, confirm the very diverse range of soil management options implemented by small scale farmers and point towards various potential options to improve the use efficiency of add organic and mineral nutrient sources for various farmer wealth classes and overall biophysical and socio-economic conditions.
- Community meetings generated a baseline of “folk ecological” knowledge in four communities of Western Kenya, along a gradient from high population density Vihiga district, through Busia, to lower population density Teso district. Culturally this gradient also extends from predominantly Luyia (Bantu) to Teso (Nilotic) speakers. Considerable common local knowledge was identified and characterised in local reports. Local soil taxonomies are quite detailed, describing soil quality as a function of topsoil colour and texture, location within the topography, and the presence or absence of signs of degradation (erosion, excessive weediness or stoniness). Since soil ‘fertility’ is perceived only through indirect means, such as the presence / absence of certain indicator plants or the vigour of crop growth, it is usually conceived of in very holistic terms (i.e.: fertility, weed and pest dynamics are strongly interrelated in local vocabulary). One of the key knowledge gaps identified is that, while many farmers recognise various crop leaf discolorations as signs of ‘low fertility’ there is not widespread understanding of there being multiple different nutrients in the soil which could be affecting crop performance. Many of the older women, who are frequently the farm managers, were not aware of the different nutrients provided by different commercially available fertilisers.

- Seminars held to share findings between the sites led to community-level mapping of the soil types and transect ground-truthing exercises to further refine and verify the local soil classifications, as well as to discuss examples of various forms of soil alteration through management or neglect. Older participants revealed than many of the soil types seen today are degraded forms of older soil types, whereas younger farmers assumed the soils of today had also existed in the past and that ‘a soil cannot change itself’. The locally recognised diversity of soils is greater than that depicted on scientific soil maps of the study regions. As a result, local farmers complained that experimental plots for new technologies are often not situated on enough of the local soil types for people to draw inferences about where (or if) they would be appropriate.
- Key informants have been selected and interviewed to gather their knowledge of soil fertility processes, indicators of soil fertility status changes, and the evolution of their soil management practices. Many older farmers’ felt that they cannot really apply their knowledge of how to match crops with suitable soils or agro-ecological niches because land sizes today are too small, demands for annual maize production are relentless, and access to different niches is limited now that the landscape is fully settled. One unexpected finding has been that local knowledge of soil fertility is not any less amongst younger farmers, in part because those who have stayed in the area are those who by intent (or lack of alternative options) have a commitment to agriculture. They also tended to have better understanding of soil nutrients and of potential new technologies.
- Multiple studies of the distribution and extent of knowledge on local indicators of soil fertility status and changes conducted in Teso, Busia, Siaya, and Kakamega districts conducted.
- Ethnobotanical study of plant species indicating soil fertility status and changes initiated in Meru South and adjacent districts of Central Kenya as companion study to work conducted in Latin America. (MSc student)
- Evaluation of local decision-making related to concepts of 1) high vs. low quality residues and 2) soil nutrients, using community-based demonstration plots in Western Kenya. Initial round of plots completed and follow-up activities with farmers in progress.
- Farmers, extension, and KARI-Kakamega field staff were trained in participatory monitoring and evaluation methods. Several forms of farmer recording keeping were introduced in 2001 to monitor and evaluate progress with the soil fertility management technologies. However, lack of funds has limited follow-up, which has lead to widely varying levels of farmer interest and disparate standards of data collection.
- A baseline survey of soil fertility management practices and socio-economic conditions was completed and analysed for 314 farmers in the West Kenya site. The methodology was shared with the Ugandan and Tanzanian sites. These data will now be compiled and analysed along with comparable studies conducted at the other BMZ project sites in West Africa (Togo and Benin) to produce a scientific paper relating soil fertility management practices to the contrasting socio-economic and agro-ecological conditions of the sites.
- A formal economic survey of on-farm use of organic and inorganic resources has been designed for the BMZ sites in Kenya, Tanzania, Uganda, Benin, and Togo, and will be implemented at the end of 2002 / early 2003.
- Public and private benefits and costs of different ISFM options evaluated using the policy analysis matrix (PAM) technique. This approach is particularly useful for examining the role of transaction costs and market failures in influencing profitability of new technologies. (MSc student)
- Evaluating whether the soil fertility management and livelihood enhancement needs of different classes of farmers are being met with the ISFM options currently available to them, by contrasting the profitability of different options (using gross margin analysis). (MSc student)
- Evidence for the external constraints (such as the mis-functioning of input and output markets) on adoption and use of ISFM options documented and explained. For example, the bumper harvest reported in Kenya and Uganda in the 2001 short-rain season led to sale prices of maize that were often below production costs. In such situations, farmers face the prospective of losing money if they

sell their maize to generate cash, but there is also no incentive for them to invest in their agricultural enterprises given the policy environment they operate within. Clearly, innovations need to address food security and livelihood sustainability, not just increased production as a good in its own right. Policy interventions that would rationalise input and output markets, and buffer smallholders from their volatility, should have as their goal a) increasing farmers' opportunities to innovate, and b) making investments back into agriculture attractive. (Paper presented to ILRI-IFPRI conference on "Policies for Land use management in highland East Africa".)

- Review of African smallholder experiences with integrated soil fertility management practices found growing use, both indigenously and through participation in agricultural projects. Patterns of use vary considerably across heterogeneous agro-ecological conditions, communities and households. The potential for integrated soil fertility management to expand markets for organic inputs, labour, credit, and fertilizer explored. Markets for organic markets are hampered by inherent constraints such as bulkiness and effects on fertilizer markets are conceivably important, although no good empirical evidence yet exists on these important points. (Paper submitted to Food Policy for special issue on "Input use and input markets in sub-Saharan Africa")
- Proposal submitted to FASID (Foundation for Advanced Studies in International Development) to examine the links between improved agricultural technologies and practices and productivity change and poverty reduction in smallholder communities and households. Agricultural technologies considered will include crop, livestock, and natural resource management innovations. Technological change is taken to be improvements in productivity of existing resources and enterprises (e.g. adoption of input packages leading to higher yields of crops) as well as the shifts in the composition of resources or enterprises (e.g. adoption of higher value added crops).
- The changing theoretical and methodological approaches of integrating social science into TSBF's research activities over the past decade were examined, and strategic lessons relevant to INRM research identified. The interdisciplinary "experiment" of TSBF has steadily taken shape as a shared language of understanding integrated soil fertility management. While individual disciplines still retain preferred modes of conducting fieldwork (i.e.: participant observation and community-based learning for "social" research, replicated trial plots for the "biological" research) a more "balanced" integration of these modes is evolving around activities of mutual interest and importance, such as those relating to decision support for farmers using organic resources. Since TSBF is working constantly through partnerships with national research and extension services, it has an important role in stimulating the growth of common bodies of knowledge and practice at the interface between research, extension, and farming. To do so requires strong champions for interdisciplinary, collaborative learning from both natural and social science backgrounds, the commitment of time and resources, and patience.
- The proportion of legumes in the farming systems is very low, and integration of legumes into system is constrained mainly by socio-economic factors
- Legumes with multiple benefits were accepted by farmers than legume cover crops
- The biophysical indicators used by farmers for selection were firm root system, early soil cover, biomass yield, decomposition rate, soil moisture conservation, drought resistance and feed value as important criteria.
- The socio-economic indicators that dictated integration of legumes into systems were depended on land productivity, farm size, land ownership, access to market and need for livestock feed.
- A draft decision guide was developed by combining the biophysical and socioeconomic indicators
- The CIAT-TSBF Working Group prepared a position paper on "BNF: A key input to integrated soil fertility management in the tropics" as part of the Pre-Proposal preparation for BNF Challenge Program.
- Case studies in Latin America show that there is a consistent rational basis to the use of local indicators of soil quality and their relation to improved soil management.

- Initial plant quality parameters that best correlated with decomposion were neutral detergent fibre (NDF) and *in vitro* dry matter digestibility (IVDMD) could be useful lab-tests during screening of plant materials as green manures.
- Green manures that decomposed and released N slowly resulted in high N uptake when they were used at pre-sowing in a tropical volcanic-ash soil.
- When *Tithonia diversifolia* is to be used as a fallow species, the use of plantlets as compared to the stake method of establishment was associated with better for nutrient acquisition and use efficiency.
- Annual application of high amounts of chicken manure can lead to surface sealing and crusting in volcanic-ash inceptisols in Colombian hillsides which is reflected in reduced water infiltration and air permeability and high superficial values of shear strength.
- Extension of the preliminary dataset testing fertilizer equivalency value – organic resource quality relationships with data from the AfNet 2001 meeting and West Africa revealed that the original hypothesis put forward by Palm et al. (2001) are valid; the N fertilizer equivalency values were found to be linearly related to the N content of the organic resources for resources with a N content above 2.4% and the slope of the relationship between both characteristics was substantially lower for materials containing a large amount of soluble polyhenols.
- Resource flow maps, drawn in various sites across East Africa, confirm the very diverse range of soil management options implemented by small scale farmers and point towards various potential options to improve the use efficiency of add organic and mineral nutrient sources for various farmer wealth classes and overall biophysical and socio-economic conditions.

Output 2: Improved soil management practices developed and disseminated

- Biological analysis of ISFM options conducted in collaboration with System wide Livestock Programme (SLP)
- Participatory economic analysis of current ISFM options conducted at benchmark sites
- Hill placement of small quantities of fertilizers evaluated at four sites on-farm
- Establishment of credit systems to increase farmers' access to external inputs at one site in the Sahel of West Africa.
- The APSIM model over-predicts the effects of fertilizer N only for the organic-inorganic N combinations and under-predicts release of nutrients from cattle manure.
- Manure decision guides have been developed and tested with farmers in Zimbabwe Current efforts are being made to evaluate the usefulness of these guides as communication tools to enhance uptake of soil management options.
- Farmers' categorizations of manure quality correlate well with laboratory indices and can be linked to use strategies of different types of manure.
- A District co-ordinated and run soil productivity enhancement program established in Tororo District. More than 3000 farmers accessing new and improved sources of information and technology options. Project funded successfully raised for 2003-4.
- Improved dual-purpose legume and improved fodder germplasm evaluated in Uganda
- Legume cover crops and biomass transfer species for maize production in Uganda evaluated
- Economic analysis of Legume cover crops and biomass transfer species for maize production in Uganda conducted
- Updated and new extension leaflets produced
- Studies of social capital and dissemination pathways completed
- Impact of policy on land management options investigated.
- Various dual purpose grain legumes are found to perform very well in terms of BNF and biomass production in Western Kenya. A certain level of variation in access to low available soil P between the various accessions was also noted.

- Significant rotational benefits were observed on maize after both herbaceous and dual purpose grain legumes, but most of the time only when P had been applied to the legumes. A minimal amount of N fertilizer applied to the cereal following a legume led to equal or higher yields compared to the maize-maize treatment receiving a recommended dose of N fertilizer.
- Twenty farmers participated in resource flow mapping (RFM) exercises in Emuhaya sub-location, the AHI/BMZ site in Western Kenya. The objective was to characterise their soil fertility management practices for the 2000-2001 cropping seasons. The participant selection was stratified on the basis of their wealth ranking in PRA's conducted earlier. Partial nutrient balances are in the process of being calculated using NUTMON. Initial results (from both West Kenya and work in Uganda) suggest that wealth class *per se* is not a good predictor of how well the soil will be managed. Higher wealth class households may use more externally purchased inputs, but their overall nutrient balances are also frequently lower than less resource endowed households.
- Following visits by Emuhaya farmers to other regions of Kenya, local initiative has led to the creation of three farmer field schools. These groups have a broader membership than the original farmer research groups, and have stimulated considerable interest in soil fertility management using high quality manure, marketable vegetable crops (particularly kales) and improved maize and bean germplasm.
- A community resource centre begun with the Ministry of Agriculture and Livestock Development (MOALD) in Emuhaya currently lacks materials. Renovation is to start after the long rains are finished (July/August 2002) and at this time community involvement will help develop the centre in directions that meet local needs. It is proposed that decision aids and other potential extension tools generated through local research will be disseminated and tested through this centre, to better understand the potential channels of information sharing. Links are also being explored with local NGO's active in soil fertility management (SCODP) and input traders and stockists in the private sector.
- Principles for conducting research to integrate local and scientific understanding of soil fertility processes are being compiled for development of a Field Manual to support trainers, farmer leaders, and scientists.
- Draft publication on the role of social networks in the generation and sharing of agricultural information has been submitted to the International Institute for Environment and Development (IIED) for inclusion in their Gatekeeper Series.
- A decision support plot was planted in March 2002 in Emuhaya to demonstrate concepts of both a) resource quality and b) nutrient deficiency. Follow up meetings at top-dressing have generated some interest with farmers who have not previously taken part in research activities. However, a better effort at labelling and visually explaining the demonstration site will improve its potential to communicate.
- Collective activities at the harvest evaluated which organic material classes should be considered 'high' quality and identified additional local or exotic materials that could be collectively tested on the plot next season. Recommendations on new experimental designs and site locations were made and will be incorporated in next season's activities, which will also include several of the 'folk ecology' project sites.
- Land degradation in East African Highlands is at an alarming stage, and yet soil conservation practices are not well accepted as there the technologies did not participate the communities in decision making.
- Four major steps were outlined to reverse the trend of land degradation namely, participatory characterization of the determinants of land degradation, community-led soil-water conservation practices, intensification of the system through integrated soil fertility management, and enhanced collective action to address communal resources.
- Deep-rooted tropical pastures can enhance soil quality by improving the size and stability of soil aggregates when compared with soils under monocroping.

- Increasing intensity of production systems resulted in improved soil physical conditions but decreased soil organic matter and macrofauna populations with the exception of agropastoral systems evaluated where a general improvement was observed.
- Improved fallows with species such as *Tithonia diversifolia* under slash and mulch management can contribute to the rapid restoration of soil fertility that has been exhausted by continuous cassava cultivation with little or no inputs.
- Determined the influence of contrasting agropastoral systems and related P fertilizer inputs on size of P fractions in soil and their isotopic exchangeability and showed that organic P dynamics are important when soil Pi reserves are limited.
- Showed that the use of vertical tillage and agropastoral treatments can contribute to the build-up of an arable layer in low fertility savanna soils of the Llanos of Colombia as indicated by improved soil physical properties and nutrient availability.

Output 3: Ecosystem services enhanced through ISFM

- The first Phase (2002-2004) of the project on 'Conservation and sustainable management of below-ground biodiversity' (BGBD) was endorsed by the Council and Chief Executive Officer of the GEF for $5 million. TSBF-CIAT is the Executing Agency on behalf of partners in seven countries ie. Mexico, Brazil, Cote d'Ivoire, Uganda, Kenya, India and Indonesia. A successful start-up workshop was held in Wageningen in August, hosted by BOT member Ken Giller
- TSBF undertook the quantification of biological nitrogen fixation using isotope dilution technique and samples are sent to IAEA in Vienna for 15N analysis.
- The chemical analysis of samples from the long-term trials are in progress.
- Yield from the long-term trials can be increased up to five fold when organics and inorganics are used in combination in a legume cereal rotation system.
- The significant effect in a cereal rotation is not only due to the nitrogen effect of the legume but more on the change in biological soil properties.
- Food deficit in Africa is not only the function of food shortage but also quality.
- The barley-based systems offer a considerable quantity of calorie and zinc, but deficit in vitamin A and calcium.
- It was possible to suggest a balanced human nutrition by reallocation of the land through optimization models using the existing resources.
- Tropical Secondary forest regrowth following pasture abandonment in Central Amazonia rapidly sequesters C in the soil where there is greatest potential for long-term C gains.
- The slash-and-char technique that involves charcoal additions to the soil significantly increased biomass production of a rice crop in comparison to a control on a Xanthic Ferralsol from the Central Amazon and opens new possibilities to enhance C sequestration in soils in areas where burning is a common management practice.
- Introduction of improved pastures with deep rooting abilities can convert savannas from a net source to a net sink of methane. Soils under gallery forests, covering 10% of the area of the Colombian savannas, are responsible for 48% of total methane sinks. For a 20-year time horizon, the global warming potential of the Colombian savannas region under current land use distribution constitutes a very small fraction of estimated global planetary radiative contribution.
- Agroforestry systems can lead to net C accumulation in soils close to total C stocks in the primary forest; however, charcoal derived-C found to 1 m depth can account for as much as 15% of total soil C and needs to be quantified when comparing the effect of land use change on soil organic C.

Output 4. Research and training capacity of stakeholders enhanced

- Long-term management of phosphorus, nitrogen, crop residue, soil tillage and crop rotation in the Sahel undertaken
- Maintenance of soil fertility under continuous cropping in maize–bean rotation evaluated
- Long-term management of manure, crop residues and fertilizers in different cropping systems in the Sahel of West Africa conducted
- Optimum combination of organic and inorganic sources of nutrients in seven African countries
- Equivalency of fertilizer value of legume-cereal cropping established in four sites
- Phosphorus (P) placement and P replenishment with Phosphate rock established in West Africa
- Placement of phosphorus and manure evaluated
- Farmers' evaluation of soil fertility restoration technologies at two sites in the Sahel of West Africa
- TSBF Institute webpage launched
- Training manual for identifying and classifying local indicators of soil quality developed, used and incorporated into University curriculum
- Facilitated participatory M&E training at BMZ/AHI site
- Reviewed proposals and assisted the refining of social science papers presented at the AfNET-8 meeting in Arusha, May 2001.
- On-going promotion of AfNET to social scientists working in Kenyan, Ugandan, Ethiopian, and Tanzanian universities and NGO's. Economists are the largest social science constituency interested in AfNET, but the input of sociologists, geographers, and anthropologists will also help broaden the relevance of ISFM research in the region
- A participatory methodology has been developed that facilitates consensus building about which soil related constraints should be tackled first. Consensus building is presented as an important step prior to collective action by farming communities resulting in the adoption of improved soil management strategies at the landscape scale.
- 12 field days were organized in Cauca and 3 training courses were organized in the Colombian Llanos.
- Prepared and/or published 34 articles for refereed journals, 3 books, 18 book chapters and 15 articles for conference proceedings most of which which are coauthored with other institutional partners.
- 72 students are associated with the project (24 Ph.D. theses).
- Established and maintained collaborative links with NARS and ARO partners.

3.5 Progress towards achieving output milestones of the project logframe 2002

Output 1. Biophysical and socioeconomic constraints to integrated soil fertility management (ISFM) identified and knowledge on soil processes improved

- *Relationships of organic input quality to fertilizer equivalency values established; multiple benefits of organic resources quantified and incorporated into the ORD; optimum management of organic and inorganic resources established*

Information related to N fertilizer equivalency values obtained in W-Africa has been added to the information obtained in E and S Africa and was presented during the Nitrogen meeting in September 2001 in France.

Trials on the 'optimum management of low quality organic resources' were established in several sites in East and West Africa. The major objective is to determine the immediate and residual response of various cereals (maize, rice, sorghum) to application of low to medium quality materials (manure, maize stover, rice straw, etc) combined or not with various rates of urea. Preliminary results of the first season show significant responses to N in most of the sites and limited impact of the organic resources. The immediate response of these materials was rather neutral in most places, except in the Sahel where strong responses were observed. Currently, the first residual year is being determined. The trials also look at the P supply potential of various organic resources. Moderate applications of manure were observed for supply all the P required by a maize crop in Nigerian and W Kenya. This observation could not be explained in terms of amount of P supplied alone; effects on the P sorption dynamics are likely to have contributed to the observed effect.

Trials on the 'optimum N and P management in legume-cereal rotations' were established in several sites in East and West Africa. The trials look at the impact of grain and herbaceous legumes on soil fertility status. Treatments are a herbaceous legume (most of the time Mucuna) and a grain legume (mostly soybean or cowpea) followed by maize with and without application of mineral N. The legume is treated or not with TSP, and significant responses were observed to P application in most sites.. The impact of previous legumes and application of P to the legume on the need for N and P of a subsequent maize crop will be evaluated.

Trials on organic/mineral interactions are being established in 2 sites in Ethiopia (Ginchi, Mekelle). Legume species used include local species and improved varieties of 'exotic' species. The work in Mekelle is part of the PhD thesis of Kiros Habtegebriel, in Ginchi of Balesh Tulema.

The NUTMON approach was introduced at two sites in Sadore (Niger) and Samanko (Mali) to install capacity to monitor nutrient inputs and outputs from cropping systems. The packages consist of two data collection questionnaires, which were translated into French for ease of use and the NUTMON Toolbox model kit. At both sites, the work was undertaken in collaboration with ICRISAT with funding support from the system wide livestock project. Data wil be analysed in 2002.

Following the installation of NUTMON toolbox, farmer input and output inventory survey data has been collected in Mali and Niger. These data are now being logged into the model together with monitoring season data that are being recorded during the current crop and livestock activity season. The initial farm NPK balance output will be available later in 2002.

In July 2002 the ICRISAT laboratory supervisor based at Sadore in Niamey visited TSBF for training in resource quality analysis. Currently, several samples of manure and crop residue input materials used in the 2002 season network trials have been analysed for %N, % Lignin, and % Polyphenols.

- *Optimum management for combined use of organic and inorganic resources established*

Several network experiments were established at benchmark locations in different agro-ecological zones of West and East Africa to look at N fertilizer equivalencies of organics. The input materials are low quality cattle manures and crop residues (rice and maize stover). The most important research highlight is that whereas the fertilizer equivalency values of low quality manure were very poor in the Sub-humid and humid zones, their values were very high (>250%) in the semi-arid zones. Indicating that the critical value for immobilization and mineralization is site specific.

- *Soil, water, nutrient and knowledge constraints to sustainable production defined and the understanding of the role of soil biota, multipurpose germplasm, and organic and inorganic resources for sustainable management of land resources improved.*

Most of the work focussed on integrating legumes into farming systems looking at where some of the legumes could work best and analyzing the reasons why the perform best under the sets of conditions.

Legume work was established in the 2000/01 season to screen legumes in two areas, Murewa (annual rainfall 800-1000mm) and Shurugwi (annual rainfall 600mm). Results in the first season showed that the three green manures, Crotalaria grahamiana, Crotalaria juncea and Mucuna pruriens produced high biomass and added higher amounts of N to the soil compared with the grain legumes, Vigna unguiculata and Glycine max. Of the green manures, Mucuna pruriens was found to give the highest biomass and N addition to the soil on some of the sites while Crotalaria grahamiana gave higher biomass yield and N addition to the soil at some of the sites. Biomass yields were as high as 6000 kg ha^{-1} with N addition of up to 200 kg ha^{-1}. Vigna unguiculata gave higher biomass and grain yields than Glycine max with biomass as high as 2000 kg ha^{-1} and 1000 kg ha^{-1} of grain. In the second season, Crotalaria grahamiana had the highest maize yields of up to 2000 kg ha^{-1} even on the sites where Mucuna had higher biomass yields in the first season. Early incorporation gave higher yields than late incorporation. There were however no treatment differences in maize yields because of the drought that was experienced during the season causing low yields.

Experiments were setup in the 2001/02 season to establish the biophysical boundary conditions under which different legumes perform in Malawi, Zambia and Zimbabwe (Murewa and Shurugwi). Biomass yields of the legumes were generally high in the clay soils than in the sandy soils. The correlation between clay content and biomass yield was however poor probably because of the drought experienced causing moisture to be the most limiting factor. Similar trends were observed for pH, CEC, %C and available P content with biomass yields. Generally, higher biomass yields were observed for green manures than grain legumes in Zambia and Zimbabwe. There was crop failure in southern Zambia while biomass yields of up to 16 000 kg ha^{-1} of Crotalaria juncea were observed in the northern parts of the country where rainfall was high. This experiment will be repeated on the sites where biomass yields were low and maize will be planted on the sites where legume biomass yields were greater than 2500 kg ha^{-1}.

A PRA was conducted with farmers from Shurugwi to establish how smallholder farmers prioritise legumes in their farming system, establish factors determining the area allocated to legumes, farmer perceptions on legumes and green manures introduced through farmer participatory research trials and identify opportunities for increasing the role of legumes and green manures in soil fertility management. Farmers identified legumes as the second major crop in the smallholder farming system after maize. Farmers grow legumes mainly for cash and food. More than 90% of the farmers were aware of the potential of legumes especially groundnuts in improving soil fertility. Diseases and limited land available limit opportunities for expanding area under legumes. Green manures were identified as very important in reclaiming poor soils were maize yield responses, even with fertility inputs, is limited and as fallow crops. Farmers identified green manures with multiple uses as more appropriate and likely to be adopted. Multiple benefits and labour requirements were identified as the most important criteria for identifying green manures for adoption. Farmers ranked mucuna highly for its potential in improving soil fertility, controlling weed growth, controlling striga, its use as a coffee bean and that it is easier to incorporate compared to sunhemp and crotalaria. On grain legumes, groundnut was ranked first as it is the main cash crop for most smallholder farmers. Soyabeans appeared to have a much higher likelihood for instant adoption by most farmers due to its multiple benefits and high profit margins. A benefit cost analysis revealed that cowpeas had the most attractive gross margin per hectare compared to the green manure legumes. The value of the other cowpea benefit as a relish, though very important, was not included in computing the margins per hectare. The Net Present Values (NPV) for all the green manures were negative. Cowpea had a positive NPV. The biomass produced by the green manures may not have been large enough to raise the fertility status of the soils to achieve the desired yield levels for maize in the second year.

- *Soil, water, nutrient and knowledge constraints to sustainable production defined and the understanding of the role of soil biota, multipurpose germplasm, and organic and inorganic resources for sustainable management of land resources improved.*

Soils at our Central America reference sites in Honduras and Nicaragua appeared to be both N and P limited thus responding best to the combined application of N and P. One Post-Doctoral Fellow started studies in Nicaragua on “farm resource and nutrient flows” in the Wibuse watershed at the San Dionisio Reference Site in Nicaragua following training with TSBF colleagues in Africa.

In the hillsides of the Cauca department-Colombia, we made progress in the identification of some biophysical mechanisms that are related to crust formation. We found that excessive application of chicken manure as an organic fertilizer on Andean volcanic ash soils leads to soil crusting and sealing due to physical dispersion, chemical dispersion, and the interaction of soil physical and chemical characteristics.

For the Llanos of Colombia, field studies conducted at Carimagua and Matazul (Savannas) contributed to define lime and nutrient requirements for acid soil tolerant varieties of rice, maize, cowpea and soybeans in rotational production systems on heavy-textured Oxisols. Field and glasshouse studies on crop and forage components indicated that forage legumes are more efficient in acquiring P per unit root length. Comparative studies of a forage grass (*Brachiaria dictyoneura* CIAT 6133) and a legume (*Arachis pintoi* CIAT 17434) demonstrated that the legume could acquire P from relatively less available P forms from oxisols of Colombia.For the Llanos of Colombia….

The increasing attention paid to local soil knowledge in recent years is the result of a greater recognition that the knowledge of people who have been interacting with their soils for long time can offer many insights about sustainable management of tropical soils. Case studies show that there is a consistent rational basis to the use of local indicators of soil quality. Biological indicators (native flora and soil fauna) were shown to be important local indicators of soil quality related to soil management. Although benefits of local knowledge include high local relevance and potential sensitivity to complex environmental interactions, without scientific input local definitions can sometimes be inaccurate to cope with environmental change. It is argued that a joint local/scientific approach, capitalizing on complementarities and synergies, would permit overcoming the limitations of site specificity and empirical nature and allow knowledge extrapolation through space and time.

Field research in Cauca showed that decomposition and nutrient release rates by green manures of contrasting chemical composition or quality were significantly correlated with initial quality parameters often used by animal nutritionists in the lab like neutral detergent fiber (NDF) and *in vitro* dry matter digestibility (IVDMD). This observation highlights potential usefulness of these lab-based measures as screening methods for large numbers of potential green manure materials in relatively short time. Glasshouse studies showed that at pre-sowing surface application of low-quality green manures (i.e. *Calliandra calothyrsus*) and/or surface application of high quality green manures (i.e. *Indigofera constricta*) during periods of high crop demand could be seen as alternative nutrient sources for hillside farmers cropping volcanic-ash soils. We also investigated the effects of establishment in *Tithonia diversifolia*, from bare root seedlings (plantlets) and vegetative stem cuttings (stakes), because this plant has the ability to sequester nutrients from soil in its tissues, including P, and has been shown to be useful for cycling nutrients via biomass transfer and improved fallow. Nutrient uptake efficiency (μg of shoot nutrient uptake per m of root length) and use efficiency (g of shoot biomass produced per g of shoot nutrient uptake) for N, P, K, Ca and Mg were greater with plants established from plantlets than those established from stakes (is it right). Improved nutrient acquisition could be attributed to relief from P stress and possibly uptake of some essential micronutrients resulting from mycorrhizal association.

Field research carried out at Carimagua showed that both native savanna and introduced pastures develop deep root systems compared to field crops such as maize. Studies on root distribution of maize showed that most of the roots are in top 20 cm of soil depth. Application of higher amounts of lime did not improve subsoil-rooting ability of maize but contributed to greater nutrient acquisition. Cultivation with disc harrow (8 passes) markedly improved maize growth and nutrient acquisition. We made progress in demonstrating the importance of deep-rooted tropical pastures to enhance soil quality by improving the size and stability of soil aggregates when compared with soils under monocropping. The concepts and strategies developed from this work are relevant to different areas of the Llanos for improving soil quality and agricultural productivity.

- *Decision guides for ISFM developed; a strategy for the wider use and dissemination of the ORD and decision guides developed and implemented*

Resource flow maps were drawn calculated for various farms belonging to various wealth classes in Lushoto (Tanzania), Western Kenya, Iganga (Uganda), Mekelle (N Ethiopia), Ginchi (W Ethiopia), Hirna (E Ethiopia), and Areka (S Ethiopia). Currently the partial nutrient balances are being calculated and evaluated with the NUTMON toolbox. The partial nutrient balance calculations need to be completed and the impact of wealth and overall economic environment evaluated. Idea is to get a paper out on this topic in the framework of the current projects. Follow-up NUTMON data processing meeting in Addis (planned somewhere in February 2003).

- *Contribution of SOM to crop production as influenced by organic resource quality evaluated*

Preliminary relationships between OM Q and SOM characteristics are being investigated in existing medium-to-long term trials (Meru, Kabete, Nyabeda) where organic resources of varying quality have been applied (all trials contain Tithonia and Calliandra applications). The delta 13C technique will be used. The SOM status (quantity and quality) of soils will be related to a set of specific soil properties essential for proper crop growth in an attempt to 'valorize' SOM. The use efficiency of mineral fertilizer is being determined using 15N labeled fertilizer, in a set of treatments of the trials (control, Calliandra, Tithonia) to determine relationships between SOM status and fertilizer use efficiency. The soil properties to include in the evaluation work will be decided upon and preliminary relationships between SOM status and these properties will be evaluated. The samples from the microplots will be analyzed before the end of the year and preliminary N recoveries calculated. These activities are implemented through MSc projects of M Kirunditu and B Waswa.

As set of trials looking at relationships between organic matter quality, environment, and soil organic matter quantity/quality have been established in Embu and Machanga (Kenya) and or going to be established near Kumasi (Ghana) and in Zimbabwe. Inputs are: Tithonia or Crotalaria, Leucaena of Calliandra, maize stover, sawdust, and manure. The organic resources are applied sole and in presence of N fertilizer. The trials are expected to run for at least 5 years. Further back-stopping of the trials in Kenya, Ghana and Zimbabwe.

Output 2: Improved soil management practices developed and disseminated

- *Biological analysis of ISFM options conducted*

In 2001 TSBF was partner in the project of improving crop-livestock systems in the dry Savannah of West Africa with funding from the System wide Livestock Programme (SLP). The activities of this project were established in different sites in Nigeria, Niger and Mali. Most of the activities of TSBF were undertaken in Niger to evaluate on-farm best bet integrated soil fertility management following a rainfall gradient from 400 mm to 800 mm. The best bet options identified are the use of small quantities of fertilizers (4 kg P/ ha) hill placed at planting time, the combination of organic amendments such as manure and crop residue with mineral fertilizers and the increase of cowpea in the cropping systems due to the very positive effect of rotations of cowpea with cereals. The effect of crop residue use as mulch is more critical in the drier zone than in the high rainfall zone. Although the rotation of cereal with cowpea can double the succeeding cereal yield and cowpea is an important cash crop, farmers are not enthusiastic to adopt this option. The adoption of the hill placement of small quantity of fertilizer can double crop yields.

Trials looking at the impact of cut-and-carry systems on nutrient balance were established in 2 sites (a poor and a fertile soil) in Nyabeda, Western Kenya in August 2001. Treatments are Tithonia, Calliandra, and natural fallow. The aboveground biomass production in these treatments is to be cut continuously and applied to a maize and kale crop. As such, the nutrient status under the shrubs and its effect on the quality of the aboveground biomass can be evaluated, together with the response of two important crops to organic matter application. Tithonia biomass production was about double as much on the fertile compared to the poor soil. No other data are available yet as the trials are just recently established. Evaluation of the response of maize and kale to the application of Tithonia and Calliandra residues.

Trials looking at the impact of grain and herbaceous legumes on soil fertility status were established in East and West Africa during the first or second season of 2001. Treatments are a herbaceous legume (most of the time Mucuna) and a grain legume (mostly soybean or cowpea) followed by maize with and without application of mineral N. The legume is treated or not with TSP, and significant responses were observed to P application in most sites.

Various classes of legumes (herbaceous, fodder, tree, grain) are being screened in Ginchi (W Ethiopia) and Mekelle (N Ethiopia) for their potential to accumulate biomass and supply N to the soil. No data are available yet as the trials are just recently established.

Demonstration trials to evaluate with farmers the organic resource quality concept were established in BMZ benchmark villages. No data are available yet as the trials were just recently established (April 2002).

- *Participatory economic analysis of current ISFM options conducted at benchmark sites*

A PhD student at the economic department of Purdue university used the field data collected to write his PhD dissertation with John Sanders and thesis is already published.

Collaborative research continue with ICRISAT and FAO in Niger on the removal of the barriers to the adoption of soil fertility restoration technologies through the introduction of the Warrantage Credit Facility in the Sudano Sahelian zone and a progress has been prepared. The Warrantage Credit Facility was initiated to remove barriers to the adoption of soil fertility restoration. It provides access to cash credit to enable farmers to purchase external inputs such as fertilizers, while using storage of crops to enable farmers to get higher prices during the period when market supply begins to decline. In Karabedji, a village of western Niger, fertilizer consumption increased 10 fold from 350 to 3600 kg due to the warrantage system.

- *Relevant knowledge, methods and decision tools for improved soil management to combat soil degradation, increase agricultural productivity and maintain soil health provided to land users in the tropics*

APSIM was used to simulate manure technologies, improved manure storage and organic-inorganic N combination technologies. The model failed to simulate trends that were observed in the field for the improved manure storage systems. The model predicts high maize yields in the season of manure application for both high and low manures followed by yield decreases in the subsequent seasons, and this trend was true for high quality manure. The model under-predicts maize yields for high quality manure in the three seasons while for low quality manure the model over-predicts yields in the first season and under-predicts in the second and third seasons. In the field however, there were yields were low in the first season followed by yield increases in the second and third seasons for the low quality manure. For the organic-inorganic N combinations, APSIM over-predicts the effects of fertilizer N only.

Manure decision guides have been developed and tested with farmers in Zimbabwe (see attached paper). Current efforts are being made to evaluate the usefulness of these guides as communication tools to enhance uptake of soil management options. There are, however, still a lot of issues that need to be covered to simplify the farmer decision guide and make it easier to use, for example determining the quality parameters and ranges for the different manures available to the farmers.

A follow up PRA exercise was carried out to correlate the farmers' quality parameter and laboratory indices on manure quality three districts of Zimbabwe (see attached paper). This was followed by field trials with manures from different categories to test their effects on maize yield. Low maize yields were observed because of the drought, resulting in no treatment differences. Maize will be planted in the second season to test the residual effects of the manures. Use strategies were linked to manure quality however, there is need to explore these aspects further.

Other farmer participatory experiments on manure and mineral fertilizer combinations, and soil moisture and nutrient conservation were not successiful. Differences in treatments on the trials were not observed due to the drought. Farmers expressed great interest in having these trials established again for the 2002/3 season.

A logit model was used to analyse the determinants of adoption of pit storage system by smallholder farmers. The variables considered for the analysis were the age of the household head, number of cattle owned, educational status of the household, interaction of the household with extension agents, labour availability, experience of using manure and the total household income. Most of these factors were not statistically significant in explaining adoption of the pit storage system. The age of the household head and the number of cattle owned were significant in explaining the adoption of the pit storage system at 5%. Younger farmers were found to have a higher probability of adopting the pit storage system compared to the older farmers. This could be explained by the fact that young farmers have a lower risk aversion and that they are still able bodied and able to cope with the additional labour demands associated with pitting manure. Farmers with large heads of cattle had a lower probability of adopting pit storage system. Those farmers with larger heads of cattle were able to compensate for the poor quality of the manure by applying higher rates of manure per hectare. This could also be a reflection of the labour demands for storing large quantities of manure in a pit. The experience of using manure was statistically significant in explaining adoption at 10%. Farmers with experience using manure were in a better position to accurately assess the risk and returns of pit storing manure compared to heaping the manure.

- *Relevant knowledge, methods and decision tools for improved soil management to combat soil degradation, increase agricultural productivity and maintain soil health provided to land users in the tropics*

The concept of building an 'arable layer' has developed from the limited success of introducing intensive as well as no-till systems into acid-soil savannas in Colombia. In practice, this involves vertical tillage practices to overcome physical constraints, an efficient use of amendments and fertilizers to correct chemical constraints and imbalances, and the use of improved tropical forage grasses, green manures and other organic matter inputs such as crop residues, to improve the soil's "bio-structure" and biological activity. The use of deep-rooting plants in rotational systems to recover water and nutrients from subsoil is also envisaged in this scheme.

Intensification of agricultural production on the acid-soil savannas of south America (mainly Oxisols) is constrained by the lack of diversity in acid (aluminum) tolerant crop germplasm, poor soil fertility and high vulnerability to soil physical, chemical and biological degradation. Out of a suite of croppings system options including monocropping, rotation with grain legumes, green manures and agropastoral systems compared with native savanna, only agropastoral systems (including maize/*Panicum maximum+legume cocktail = Arachis pintoi, Centrosema acutifolium, Glycine wightii, Stylosanthes capitata) and rice/Brachiaria humidicola + legume cocktail,*) were able to simultaneously improve the physical, chemical and biological properties of the soil.

We investigated the effect of land-use systems and P fertilizer inputs on size of P fractions and their isotopic exchangeability. Differently managed Colombian Oxisols were labeled with carrier free ^{33}P and sequentially extracted after different incubation times. The recovery of ^{33}P in the two soils with annual fertilizer inputs and large positive input-output P balances indicated that resin-P_i, Bic-P_i and NaOH-P_i contained most of the exchangeable P. The organic or more recalcitrant inorganic fractions contained almost no exchangeable P. In contrast, in soils with low or no P fertilization, more than 14% of added ^{33}P was recovered in NaOH-P_o and HCl-P_o fractions two weeks after labeling, showing that organic P is involved in short term P dynamics.

In the Andean hillsides we have shown that an improved fallow with species such as *Tithonia diversifolia* in a slash and mulch system can contribute to the rapid restoration of soil fertility that has been exhausted after years of cropping with little or no inputs. Increased biomass production, greater accumulation and recycling of plant nutrients, especially phosphorus, with introduced fallow species are the reasons for the observed increases in soil fertility and biological activity. *Tithonia* has been shown to increase the pool of plant-available phosphorus.

Output 3: Ecosystem services enhanced through ISFM

- *The soils capacity to provide ecosystem services (global warming potential, water quality and supply, erosion control, nutrient cycling) and maintain soil biodiversity in the face of globl change in land use and climate enhanced*

In a unique study for tropical savannas we have shown that the introduction of improved pasture species with deep rooting capacities can convert the agroecosystems of the savannas from a net source of global warming potential (total greenhouse gas emissions of carbon dioxide, nitrous oxide and methane) into a net negative potential or sink. The study is the first to collect data on all greenhouse gas emissions from different land management practices (cropping and pastures) and develop an overall global warming potential based on current and projected land use.

Output 4. Research and training capacity of stakeholders enhanced

- *Research and training capacity of stakeholders in the tropics in the fields of soil biology, fertility and tropical agroecosystem management enhanced through the dissemnation of principles, concepts, methods and tools.*

A participatory approach in the form of a methodological guide has been developed and used in Latin America and the Caribbean (Honduras, Nicaragua, Colombia, Peru, Venezuela, Dominican Republic) and Africa (Uganda, Tanzania) in order to identify and classify local indicators of soil quality related to permanent and modifiable soil properties. This methodological tool aims to empower local communities to better manage their soil resource through better decision making and local monitoring of their environment. It is also designed to steer soil management towards developing practical solutions to identified soil constrains, as well as, to monitor the impact of management strategies implemented to address such constraints. The methodological approach presented here constitutes one tool to capture local demands and perceptions of soil constraints as an essential guide to relevant research and development activities. A considerable component of this approach involves the improvement of the communication between the technical officers and farmers and *vice versa* by jointly constructing an effective communication channel. The participatory process used is shown to have considerable potential in facilitating farmer consensus about which soil related constraints should be tackled first. Consensus building is presented as an important step prior to collective action by farming communities resulting in the adoption of improved soil management strategies at the landscape scale.

- *Optimum combination of organic and inorganic sources of nutrients*

In 2002, network experiments were conducted at 7 benchmark locations across 7 countries to investigate the nitrogen and phosphorus contribution of different low quality organic materials that are available for direct use by farmers. The sites include: Banizoumbou, Niger (*Interaction of N, P and manure; Biological nitrogen fixation; Combining organic and inorganic plant nutrients for cowpea production);* Maseno, Western Kenya; Kogoni, Mali; Farakou Ba, Kou Valley, Burkina Faso; Zaria, Nigeria; Kumasi, Ghana; Davie, Togo; Kabete, Kenya.

- *Fertilizer equivalencies of legume-cereal cropping*

For establishing equivalency of fertilizer value of legume-cereal cropping, experiments were established at Maseno in Western Kenya, Zaria in Nigeria, Kumasi in Ghana and Davie in Togo.

Other aspects evaluated are Phosphorus (P) placement and P replenishment with Phosphate rock, Placement of phosphorus and manure, and farmer evaluation of soil fertility restoration technologies (Karabedji and Sadore).

4. Indicators

Appendix A: List of Publications

4.1 Refereed journals

Amézquita, E., R. J. Thomas, I. M. Rao, D. L. Molina and P. Hoyos. 2002. The influence of pastures on soil physical characteristics of an oxisol in the eastern plains (Llanos Orientales) of Colombia. Agriculture, Ecosystems and Environment (in press).

Barrios E. and Trejo M.T. (2002) Implications of local soil knowledge for integrated soil fertility management in Latin America. Geoderma (in press)

Barrios, E., J. G. Cobo, I. M. Rao, R. J. Thomas, E. Amézquita and J. J. Jiménez. 2002. Fallow management for soil fertility recovery in tropical Andean agroecosystems in Colombia. Agriculture, Ecosystems and Environment (in press).

Bationo A. and Buerkert A (2001). Soil organic carbon management for sustainable land use in the Sudano-Sahelian West Africa. Nutrient Cycling in Agroecosystems 61:131-142.

Bationo, A., and Ntare, B.R. (2000). Rotation and nitrogen fertilizer effects on pearl millet, cowpea and groundnut yield and soil chemical properties in a sandy soil in the semi-arid tropics, West Africa. Journal of Agricultural Science 134: 277-284

Bielders, C.L., Michels, K., and Bationo, A. (2002). On-farm evaluation of ridging and residue management options in a Sahelian millet-cowpea intercrop. 1. Soil quality changes. Soil Use and Managemnet 18

Buehler, S., A. Oberson, I. M. Rao, E. Frossard and D. K. Friesen. 2002. Sequential phosphorus extraction of a 33-P labeled oxisol under contrasting agricultural systems. Soil Science Society of America Journal 66: 868-877.

Buerkert, A., Bationo, A., and Piepho, H.P. (2001). Efficient phosphorus application strategies for increased crop production in sub-Saharan West Africa.Field Crop Research 72: 1-15.

Buerkert, A., Piepho, H.P. and Bationo A. (2002) Multi-site time trend analysis of soil fertility management effects on crop production in Sub-Saharan West Africa. Expl. Agric 38: 163-183.

Burkert, A., Bagayoko, M., Alvey, S., and Bationo, A. (2001). Causes of legume-rotation effects in increasing cereal yields across the Sudanian, Sahelian and Guinean zone of West Africa. Developments in Plant and Soil Sciences 92: 972-973

Cobo J.G., Barrios E., Kass D.C.L., Thomas R.J. (2002a) Decomposition and nutrient release by green manures in a tropical hillside agroecosystem. Plant and Soil 231:211-223.

Cobo J.G., Barrios E., Kass D.C.L., Thomas R.J. (2002b) Nitrogen mineralizatio and crop uptake from surface-applied leaves of green manure species on a tropical volcanic-ash soil. Biol.Fert. Soils 36:87-92.

Delve, R.J. and Jama, B. *Mucuna pruriens* and *Canavalia ensiformis* legume cover crops: Sole crop productivity, nutrient balance, farmer evaluation and management implications. (Submitted to Biology and Fertility of Soils)

Koutika LS, N Sanginga, B Vanlauwe and S W Weise 2002 Chemical properties and soil organic matter assessment under fallow systems in the forest margins benchmark. Soil Biology and Biochemistry 34, 757-765.

Murwira, H.K. and T.L. Kudya.2002. Economics of heap and pit storage of cattle manure for maize production in Zimbabwe. Tropical Science, 42: 153-156.

Nyende, P., and Delve, R.J. Farmer participatory evaluation of legume cover crop and biomass transfer technologies for soil fertility improvement using farmer criteria, preference ranking and log it regression analysis in eastern Uganda. (Submitted to Experimental Agriculture)

Oberthur T., Barrios E., Cook S., Usma H. and Escobar G. 2002. Helping soil scientists and Andean hillside farmers to see the obvious about soil fertility management. Agriculture, Ecosystems and Environment (in review).

Phiri, S., E. Amezquita, I. M. Rao and B. R. Singh. 2002. Constructing an arable layer through chisel tillage and crop-pasture rotations in tropical savanna soils of the Llanos of Colombia. Journal of Sustainable Agriculture (in press).

Phiri, S., I. M. Rao, E. Barrios, and B. R. Singh. 2002. Plant growth, mycorrhizal association, nutrient uptake and phosphorus dynamics in a volcanic-ash soil in Colombia as affected by the establishment of *Tithonia diversifolia*. Journal of Sustainable Agriculture (in press).

Place, F.P., Freeman, A., Ramisch, J.J., Vanlauwe, B., Barrett, C., 2003. "Integrated soil fertility management: evidence on adoption and impact in African smallholder agriculture." *Food Policy*.

Ramisch, J.J. "Whose soil degradation counts? Nutrient balances and soil fertility policy for Africa" submitted to *Land-use Policy*.

Ramisch, J.J., [revised and resubmitted] "Inequality, agro-pastoral exchanges and soil fertility gradients in Southern Mali." *Agriculture, Ecosystems, and Environment*.

Sharrock, R. A., F. L. Sinclair, C. Gilddon, I. M. Rao, E. Barrios, P. J. Mustonen, P. Smithson, D. L. Jones and D. L. Godbold. 2002. A global assessment of mycorrhizal colonization of *Tithonia diversifolia*. Molecular Ecology (in review).

Sinaj, S., Buerkert, A., El-Hajj, G. , Bationo, Traor´ e, A.,H. & Frossard, E. Effects of fertility management strategies on phosphorus bioavailability in four West African soils Plant and Soil 233: 71–83, 2001.

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4.6. Working Papers, Other Presentations or Publications

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Delve, R.J., Nyende, P., Jama, B., and Kabuye, F. Mapping improved fallows in Tororo district, Uganda: lessons learnt. Poster presentation at the Advancing impact of Agroforestry research and Development in the ECA Region - Regional Technical and Planning Workshop, Nairobi, 3rd-8th February 2002.

Esilaba, A.E., Byalebeka, J.B., Nakiganda, A., Mubiru, S., Ssenyange, D., Delve, R.J., Mbalule, M. and Nalukenge, G. December 2001. Integrated nutrient management in Iganga District, Uganda: Diagnosis by participatory learning and action research. CIAT Africa Occasional Publication Series, No. 35 (Working Paper)

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Tumuhairwe, J.B., R.J. Delve, B. Jama, M. Rwakaikara-Silver. Nitrogen fertiliser values of leguminous fallows in eastern Uganda. Poster presentation at the Advancing impact of Agroforestry research and Development in the ECA Region - Regional Technical and Planning Workshop, Nairobi, 3rd-8th February 2002.

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Other publications:

Amézquita, E., L.F. Chávez, J.H. Bernal. 2002. Construcción de una "capa arable" en suelos pobres: conceptos esenciales aplicados en la altillanura. Folleto Divulgativo. Colaboración Colciencias, Ciat, Corpoica.

Agroecology Highlight bulletins on:

1. Integration of local soil knowledge for improved soil management strategies
2. Farmers evaluations and innovations with legume cover crops
3. Going to scale with improved fallow options: More benefits, more people, more quickly
4. Resource flows and nutrient balances in smallholder farming system in eastern Uganda

Appendix B: Research training capacity of stakeholders enhanced

Name	Nationality	Education	Institution	Research theme
D. Fatondji	Nigerian	Ph.D.	University of Bonn, Germany	Interaction between water harvesting and soil fertility
Vincent Bado	Burkinabe	Ph.D.	Laval University in Quebec, Canada	Interaction between organic and inorganic nutrient sources in different cropping system in the Sudano sahelian zone of West Africa
Shamie Zingore	Zimbabwean	Ph.D.	Wageningen University, Netherlands	Evaluation of the nutrient use effciencies of resource management options in smallholder crop-livestock farming systems in Zimbabwe
Chris Nyakanda	Zimbabwean	Ph.D.	University of Zimbabwe	Effects of Sesbania sesban and cajanus cajan improved fallows on soil moisture and nutrient dynamics and on maize performance in medium rainfall areas of Zimbabwe
Nhamo Nhamo	Zimbabwean	Ph.D.	University of Zimbabwe	An avaluation of the efficacy of organic and inorganic fertilizer combinations in supplying N to crops
Jean Nzuma	Zimbabwean	Ph.D.	University of Zimbabwe	Manure management options for increasing crop production in smallholder farming systems of Zimbabwe
Bonaventure Kayinamura	Rwandan	Ph.D.	University of Zimbabwe	Potential use of three plant species: Glycine Max, mucuna pruriens and crotalaria grahamiana as soil fertility ameliorants in smallholder farming systems in Zimbabwe: synergistic improvements of water and nutrient use efficiencies
Fredrick Ayuke	Kenyan	Ph.D.	University of Nairobi, Kenya	Assessing diversity and population dynamics of macrofauna (earthworms and termites) as influenced by land-use change and impact on soil properties
Margaret Mwangi	Kenyan	Ph.D.	University of Nairobi, Kenya	Soil functional groups: evaluation of ecosystem engineers and soil fertility management within agro forestry ecosystems

Name	Nationality	Education	Institution	Research theme
Susan Ikerra	Tanzanian	Ph.D.	Sokoine University, Tanzania	Effect of organic materials on MPR dissolution on an Ultisol in Morogoro, Tanzania
Kiros Habtegebriel	Ethiopian	Ph.D.	Norway Agricultural University	Development and evaluation of site-specific integrated nutrient management practices for wheat on Vertisols in semi-arid Northern Ethiopia
Jane Kapkiyai	Kenyan	Ph.D.	Cornell University, USA	Effects of Legume Green Manures on Crop Productivity and Nutrient Cycling in Maize-based Cropping Systems of Western Kenya
John Ojiem	Kenyan	Ph.D.	Wageningen University, Netherlands	Management of legume green manures in Western Kenya
Mercy Kamau	Kenyan	Ph.D.	Wageningen University, Netherlands	Socio-economic evaluation of legume-based systems in Western Kenya
Twaha Atenyi	Ugandan	Ph. D.	Agricultural University of Norway	Soil phosphorus transformations and organic matter dynamics
Nelson Castañeda	Colombian	Ph.D.	University of Gottingen	Genotypic variation in P acquisition & utilization in *A. pintoi*
Brigit Krucera	German	Ph. D.	University of Freiburg	Characterization of bean genotypes for abiotic stress adaptation
Alvaro Rincon	Colombian	Ph.D.	National University	Integration of maize with forages to recuperate degraded pastures in the Llanos of Colombia
Karen Tscherning	German	Ph.D.	University of Hohenheim	Simultaneous evaluation of tropical forage legumes for feed value and soil enhancement
Elena Velásquez	Colombian	Ph.D.	National University/ IRD	Biological indicators of soil quality based on macroinvertebrate communities and relationships with soil functional parameters
Armando Torrente	Colombia	Ph.D	U.Nacional, Palmira	Soil-water movement in Magnesic soils
Christian Thierfelder	Germany	Ph.D.	Univ.Hohenheim, Germany	Development of soil preserving land use systems in the tropics
Martha Ligia Castellanos	Colombia	Ph.D.	U.Nacional, Palmira / U. of the Guajira	Discussion in a new topic of research

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Yolanda Rubiano	Colombia	Ph.D.	U.Nacional, Palmira	Soil degradation indicators for the Llanos
Ruth Kangai Adiel	Kenyan	M.Sc.	Kenyatta University, Kenya	Assessment of the adoption potential of soil fertility improvement technologies in Chuka Division, Meru South, Kenya
Monicah Mucheru	Kenyan	M.Sc.	Kenyatta University, Kenya	Enhancement of soil productivity using low-cost inputs
James Kinyua	Kenyan	M.Sc.	Kenyatta University, Kenya	Nutrient management by use of agroforestry trees for improved soil productivity
Joseph Kimetu	Kenyan	M.Sc.	Kenyatta University, Kenya	Nitrogen fertilizer equivalencies based on organic input quality
John Baptist Tumuhairwe	Ugandan	M.Sc.	Makerere University, Uganda	Effect of short-duration C*rotalaria grahamiana* and *Mucuna pruriens* fallows on soil productivity in southeastern Uganda
Matthew Kuule	Ugandan	M.Sc.	Makerere University, Uganda	The effect of green manures, Mucuna, Lablab, Canavalia and Crotalaria on soil fertility and productivity in Tororo District, Uganda
Dennis Wafula	Kenyan	M.Sc.	Jomo Kenyatta University, Kenya	The contribution of different feeding guilds of termites to nutrient cycling in soil
Pamela Pali	Ugandan	M.Sc.	Makerere University, Uganda	The acceptance and profitability of biomass transfer and legume cover crops in Tororo district, Uganda
Ali Lule	Ugandan	M.Sc.	Makerere University, Uganda	The role of social capital in adoption of soil fertility technologies
Abas Isabirye	Ugandan	M.Sc.	Makerere University, Uganda	Communication flow between service providers and farmers
Paul Bagenze	Ugandan	M.Sc.	Makerere University, Uganda	Linking farmers preferences and GIS for targeting of soil fertility technologies
Patricia Namwanda	Ugandan	M.Sc.	Makerere University, Uganda	Techniques and criteria for extrapolation of soil fertility technologies: From farm to the regional level

Name	Nationality	Education	Institution	Research theme
Eria Bulega	Ugandan	M.Sc.	Makerere University, Uganda	Extrapolation domains for countrywide targeting of legume cover crop technologies
A.N. Other	Ugandan	M.Sc.	Makerere University, Uganda	Utilization of dual-purpose live barriers for soil water conservation and increased household income
John Mutihero	Zimbabwean	M.Sc.	University of Zimbabwe	An assessment of profitability of cattle manure use and the relative impacts on rural farming households in Mangwende communal area, Zimbabwe
U. Chipfupa	Zimbabwean	M.Sc.	University of Zimbabwe	The potential of decision guides as an extension tool in improving adoption of integrated soil fertility management options
Charles Nhemachena	Zimbabwean	M.Sc.	University of Zimbabwe	Comparative analysis of grain legume production and domestic consumption trends in Zimbabwe' s dual farming sector and the policy challenges for the post land reform era
Julius Mumo Maithya	Kenyan	M.Sc.	University of Nairobi	The Competitiveness of Agroforestry-based and other Soil Fertility Enhancement Technologies for Smallholder Food Production in Western Kenya
Somoni Franklin Mairura	Kenyan	M.Sc.	Kenyatta University, Kenya	The Competitiveness of Agroforestry-based and other Soil Fertility Enhancement Technologies for Smallholder Food Production in Western Kenya
Pablo Tittonell	Argentina	M.Sc.	Wageningen University, Netherlands	Farmer-induced soil fertility gradients and their impact on soil processes affecting the efficiency of nutrient capture in smallholder farming systems in East Africa
Mercy Karunditu	Kenyan	M.Sc.	Kenyatta University, Kenya	Nitrogen fertilizer use efficiency as affected by soil organic matter status in Eastern, Central, and Western Kenya
Boaz Waswa	Kenyan	M.Sc.	Kenyatta University, Kenya	Soil Organic Matter Status under Different Agroforestry Management Practices in Three Different Sites in Kenya

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Adriana Arango	Colombian	M.Sc.	National University	Identification of candidate genes for aluminium resistance in *Brachiaria*
Oscar Molina	Colombian	M.Sc.	National University	Effect of residual P fertilizer and organic manure application on mycorrhizal association of maize-bean rotation in P-fixing Andisol in Cauca, Colombia
José Trinidad Reyes	Honduran	M.Sc.	National University	Potential influence of mycorrhizal external mycelia on the recuperation of degraded soils in Cauca, Colombia
Ivonne Valenzuela	Colombia	M.Sc.	U.Nacional, Palmira	Relationship between free soil water and its composition in Vertisols
Jaime Lozano Fernández	Colombia	M.Sc.	U.Nacional, Palmira	Variability of soil physical properties in CIAT Experimental Station
José Augusto Rodríguez	Colombia	M.Sc.	U.Nacional, Palmira	Influence of some a amendments in some physical, chemical and biological characteristics of a magnesium soil.
Mariela Rivera	Colombia	M.Sc.	U.Nacional, Palmira	Chemistry of tropical soil
Maryory Rodríguez A.	Colombia	M.Sc.	U.Uberlandia, Brazil	A comparison between Colombian and Brazilian Oxisols
Maria E. Baltodano	Ncaragua	M.Sc.	Universidad de Guatemala	Methods to assess the economical value of environmental services
Pauline Chivenge	Zimbabwean	M.Phil	University of Zimbabwe	Tillage effects on soil organic matter fractions in long term maize trilas in Zimbabwe
Killian Mutiro	Zimbabwean	M.Phil	University of Zimbabwe	Adoption of improved manure storage systems by smallholder farmers in drought prone and high potential areas of Zimbabwe
Nelson Juma Otwoma	Kenyan	MA	University of Nairobi	The role of indigenous knowledge in the management of soil fertility among smallholder farmers of Emuhaya division
L. Rusinamhodzi	Zimbabwean	B.Sc.	University of Nairobi	Linking farmer criteria and laboratory indices for on-farm prediction of manure quality in smallholder farming areas of Zimbabwe

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Talkmore Mombeyarara	Zimbabwean	B.Sc.	University of Nairobi	The potential of *Ipomoea stenosiphon* (Gubvuwa) plant as a soil fertility ameliorant: A comparison with other agroforestry species
German Manrique	Colombian	B.Sc.	National University	Screening of common bean genotypes for aluminium resistance
Luisa F. Escobar	Colombian	B.Sc.	Javeriana University	Symbiotic potential of native rhizobia under different land use systems in Cauca, Colombia
Lorena Parra Lopez	Colombian	B.Sc.	University of Valle	Screening methods for aluminium resistance in common bean
Enna Diaz Betancourt	Colombia	B.Sc.	Fund. Universitaria de Popayán	Soil physical characterization in Cauca Paramo soils
José Manuel Campo	Colombia	B.Sc.	U. Nacional, Palmira	Evaluation of some crop systems in relation to erosion in Volcanic Ash Soils (Pescador)
Liliana Paz Betancourt	Colombia	B.Sc.	Fund. Universitaria de Popayán	Soil physical characterization in Cauca Paramo soils
Lina María Gaviria	Colombia	B.Sc.	U.Suramericana, Neiva	Characterization of surface biogenic structures under different cassava treatments in Santander de Quilichao
Rafael Andrés Jaramillo O.	Colombia	B.Sc.	U.Nacional, Palmira	The influence of the intensity of soil management in some physical conditions in CIAT Station
Roberto Arturo Viveros A.	Colombia	B.Sc.	U.Nacional, Palmira	The influence of the intensity of soil management in some physical conditions in CIAT Station
German Manrique	Colombian	B.Sc.	National University	Screening of common bean genotypes for aluminium resistance
Maria E. Butrago	Colombian	B.Sc.	University of Valle	Screening of *Brachiaria* hybrids for aluminium resistance
Orlando Mejia	Honduras	B.Sc.	MSEC Consortium	Training in the use of the PCARES model