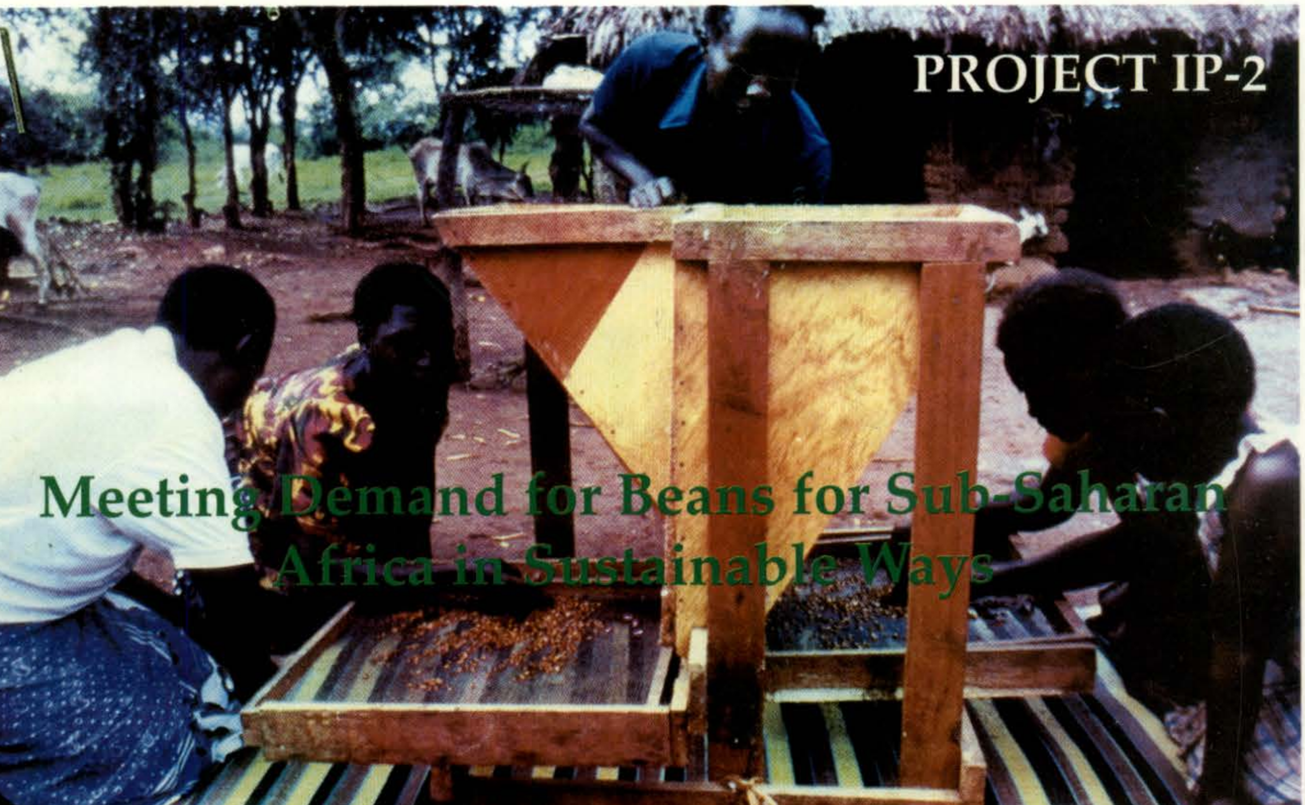
ANNUAL REPORT 2000



Mahai Women's Seed Producer Group in Uganda

CIAT
Centro Internacional de Agricultura Tropical
International Center for Tropical Agriculture

The mission of the International Center for Tropical Agriculture (CIAT, its Spanish acronym) is to reduce hunger and poverty in the tropics through collaborative research that improves agricultural productivity and natural resource management.

CIAT is one of 16 international agricultural research centers sponsored by the Consultative Group on International Agricultural Research (CGIAR).

The Center's core budget is financed by 30 donor countries, international and regional development organizations, and private foundations. In 2000, the donor countries include Australia, Belgium, Brazil, Canada, Colombia, Denmark, France, Germany, Italy, Japan, Mexico, the Netherlands, New Zealand, Norway, Peru, South Africa, Spain, Sweden, Switzerland, the United Kingdom, and the United States of America. Donor organizations include the European Union (EU), the Ford Foundation, and the Inter-American Development Bank (IDB), the International Development Research Centre (IDRC), the International Fund for Agricultural Development (IFAD), the Kellogg Foundation, the Nippon Foundation, the Rockefeller Foundation, and the World Bank. These and other donors also finance the Center's competitive projects.

ANNUAL REPORT 2000

PROJECT IP-2

Meeting Demand for Beans in Sub-Saharan Africa in Sustainable Ways

CIAT
Centro Internacional de Agricultura Tropical
International Center for Tropical Agriculture

PROJECT: IP-2

Title: Meeting Demand for Beans in Sub-Saharan Africa in Sustainable Ways

Objectives: To improve bean productivity in Sub-Saharan Africa by deploying gene pools that help solve major production constraints and by supporting networks of NARS for applied research.

Outputs: Enhanced productivity of farms on which beans are an important component. Intermediate goods include improved classification of bean environments. Gene pools with multiple stress resistance. Ecologically sound crop, soil and pest management practices. Closer farmer participation. Nonformal methods of seed production and distribution.

Gains: Varieties resistant to multiple stresses will occupy about 200,000 hectares (5% of the bean production area) in network countries. Farmers growing the new varieties will see a 10% increase in their income from marketing of beans. Five percent of farmers in the region will have adopted improved crop management practices. Regional networks will be fully devolved to local management, with CIAT participating as a research partner.

Milestones:

1998	Pan-Africa network integrates bean research of subregional NARS associations. Climbing beans widely adopted in Kenya and at least one other country.
1999	Lines resistant to bean fly available; multiple disease resistance developed.
2000	Farmers starting to adopt new agronomic practices, including erosion control measures and use of green manures.

Users: Small-scale farmers (mainly women) in both marginal and favorable production areas in central, eastern and southern Africa. Small-scale seed producers in countries that lack an effective formal seed sector for beans. Consumers in African urban areas dependent upon beans as an inexpensive source of protein. Multi-institutional national programs in these regions as users of germplasm and improved research methods.

Collaborators: *Reviewing priorities:* Steering committees of regional networks and of the Pan-Africa Bean Research Alliance (PABRA). *Development of improved germplasm:* NARS, and farmers for FPR. *Improvement in soil, pest and disease management:* ICRAF, CIMMYT, IITA, CIP, TSBF and national partners in the African Highlands Initiative (AHI). *Training in breeding and IPM:* Bean/Cowpea CRSP and ICIPE. *Diffusion of new technology:* NGOs, churches, relief and government agencies, entrepreneurs, universities in the Netherlands, Switzerland, UK and USA, and DFID (UK).

CG system linkages: Breeding (50%), Crop Production Systems (20%), Protecting the Environment (10%), Training (10%), Networks (10%). Participates in the African Highlands Initiative.

CIAT Project linkages: Provision of germplasm and training for resistances to multiple constraints (IP-1). Genetic markers and characterization of African germplasm (SB-2) and gene bank materials and databases (SB-1). Collaboration in methods development and case studies (PE-1, PE-5, SN-3, BP-1). Exchange of information on regional networks (SN-2).

Project IP-2:

Title: Meeting Demand for Beans in Sub-Saharan Africa in Sustainable Ways

Project Objective:

To increase the productivity and commercialization of common bean through adoption of sustainable production technologies developed in close collaboration with national research institutions and farmers

1. Stronger networks in Africa linking NARS, IARCs, NGOs and the private sector	2. Germplasm with relevant traits developed and used widely in Africa	3. More sustainable production systems with beans developed with small farmers	4. Higher rates of technology adoption achieved
1.1 Develop new partnerships within regional networks, forging alliances with strong NARS and directly with small-scale and female farmers to address strategic research needs in generating germplasm for Africa	2.1 Use information on bean-growing environments to target more precisely germplasm that would help alleviate poverty, especially among rural women	3.1 In collaboration with NARS, farmers, and other IARCs, develop and test sustainable crop and soil management practices	4.1 Document local technology diffusion systems and develop innovative seed systems to increase adoption of new varieties, especially by women
1.2 PABRA network members coordinate activities across regions and take greater responsibility for managing regional strategies and projects	2.2 Introduce and generate improved germplasm to address principal African production constraints	3.2 Develop IPM components and strategies to reduce crop losses from pests and diseases in major production systems	4.2 Promote crop and pest management options in collaboration with local partners and farmers
1.3 Provide technical support and participate in network training events, information and germplasm exchange, and planning meetings	2.3 Design and evaluate cost-effective innovative methods for variety development, including participatory plant breeding	3.3 Design more efficient methods for systems improvement, including modeling and community-based participation (that involves females)	4.3 Develop improved methods for documenting social and environmental impacts
1.4 Assist NARS and regional associations in designing more efficient modes of managing networks	2.4 Distribute improved germplasm to network participants	3.4 Strengthen inter-center and ecoregional linkages in systems improvements, including AHI	4.4 Measure adoption and social, economic and environmental impact of research and technologies
1.5 Refine the characterization of bean growing environments by using biophysical and socio-economic data	2.5 Enhance NARS' capacity to effectively use new sources of germplasm in their variety development programs		4.5 Propose policy reforms that facilitate technology adoption in collaboration with regional and international organizations
			4.6 Investigate and publicize new market opportunities and products

Project Logframe

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Critical Assumptions
Program goal: Enhanced productivity of farms on which beans are an important component, leading to improved livelihoods especially for the poor and for women farmers.	Family production, income distribution and nutrition in important bean growing areas.	National and regional statistics	Peace, stability and a favorable economical environment
Project Purpose: To increase the productivity and commercialization of common bean through adoption of sustainable production technologies developed in close collaboration with national research institutions and farmers	Regional networks fully devolved to local management, with CIAT participating as a research partner. Varieties resistant to multiple stresses occupying about 200,000 hectares (7% area). Farmers growing new varieties see a 10% increase in income from marketing of beans. Farmers in the region starting to adopt ecologically sustainable practices.	End-of-project and Evaluation reports	Regional bodies and national governments continue to give priority to bean.
Outputs: 1. Stronger networks in Africa linking NARS, IARCs, NGOs and the private sector. 2. Germplasm with relevant traits developed and used widely in Africa. 3. Sustainable bean production systems. 4. Technology adopted.	1. Pan-Africa network integrates bean research of subregional NARS associations by 1998. 2. Lines with multiple disease resistance and resistance to stem maggot available by 1999. 3. Participatory research practiced at sites in key countries by 1999, and options for crop/pest/soil management available by 1999. 4. Climbing beans widely adopted in Kenya and at least one other country by 1998. Poor people including women in at least four major bean producing countries accessing new varieties rapidly through sustainable low-cost seed systems, and improved crop management practices adopted by 5% of farmers, by 2001.	Annual reports of PABRA, ECABREN & SABRN. Network and national program reports. National and national program reports. Adoption survey reports.	Regional bodies and national governments continue to give priority to bean. Networks bring in non-traditional partners. Sources of resistance exist and adequate germplasm support received from Project IP-1. Adequate methods interaction with NRM projects.
Inputs: Personnel. Research and travel funds. Computers and screenhouse.	1.0 FTE each in Systems Agronomy, Social Science, Pathology, Entomology, Coordination; 2.0 FTE in Breeding.	Progress reports.	Two regional networks are also fully funded.

Highlights in 2000

Meeting Demand for Beans in Sub-Saharan Africa in Sustainable Ways

Inputs

a. Investigators:

Adamo, Abra	(RF, Sociologist)	Nazreth, Ethiopia	50%
Amede, Tilahun	(SRF, Systems Agronomist/AHI)	Areka, Ethiopia	100%
Ampofo, Kwasi	(IRS, IPM Specialist)	Arusha, Tanzania	100%
Buruchara, Robin	(IRS, Plant Pathologist)	Kampala, Uganda	100%
Chirwa, Rowland	(SRF, Bean Breeder/SABRN Coordinator)	Lilongwe, Malawi	60%
David, Soniia	(IRS, Sociologist)	Kampala, Uganda	100%
Esilaba, Anthony	(SRC, Participatory Soil Fertility / SWNM)	Kampala, Uganda	100%*
Hollenweger, Ursula	(RF, Agronomist)	Arusha, Tanzania	100%
Kimani, Paul	(SRF, Bean Breeder, Univ. of Nairobi/CIAT)	Nairobi, Kenya	50%
Kirkby, Roger	(IRS, Systems Agronomist/Project Manager)	Kampala, Uganda	100%
Mukishi, Pyndji	(SRF, ECABREN Coordinator)	Arusha, Tanzania)	100%
Sanginga, Pascal	(PDF, Sociologist / PRGA)	Kabale, Uganda	50%*

Note: overall percentage time allows for staff who terminated or started during 2000

b. Cooperators and locations:

National institutions hosting regional staff: EARO Ethiopia
Univ. Nairobi, Kenya
DARTS Malawi
MoA/DRD Tanzania
NARO Uganda

Research cooperators are all NARIs, several universities, many NGOs in the following regions:
Eastern/Central Africa (9 countries)
Southern Africa (9 countries)
West Africa (1 country)

Highlights of Outputs

1. Stronger networks in Africa linking NARS, IARCs, NGOs and private sector

Novel partnerships this year permitted a decentralization of regional bean breeding to the networks. Two new CIAT positions were filled by experienced breeders from the networks, in one case as a joint appointment. As both scientists remain at their former institutional bases, the initial year's output has been very promising. In a parallel development, two national scientists monitored and supported cross-country activities (in participatory research and screening for low soil fertility), responsibilities that until last year were undertaken by CIAT international staff.

The bean networks have enthusiastically developed a new research framework based on market characterization in participating countries, with private sector and social science participation in network planning. A preliminary characterization of bean markets was carried out by the nine ECABREN countries.

Training in gender and stakeholder analysis for watershed management and in soil fertility indicators fertility was organized by PRGA and CIAT Hillsides, in support of research in five countries under the Africa Highlands Ecoregional program (AHI) and the SWNM-TSBF program in East Africa. A more explicit gender strategy was applied by CIAT staff in Africa.

2. Germplasm with relevant traits developed and used widely in Africa

The bean networks reorganised their variety development to address 7 priorities market classes. A new regional program with the University of Nairobi for multiple constraints breeding identified promising lines tolerant to two or more biotic constraints. NARS scientists also identified additional good sources of resistance to stem maggot and tolerance to soil fertility constraints from CIAT materials.

A small but critical number of new sources of moderate tolerance to Pythium root rots in beans were identified from Rwandan and CIAT-bred lines, and a good number of lines derived from crosses for multiple resistance gave promising results against this intractable problem.

In the second year of a formal comparison of participatory and conventional breeding in Ethiopia, farmers were clearly influenced by characteristics of their familiar varieties, yet selected enthusiastically some unknown seed types. Selection criteria used by a male-dominated group and by women were significantly different, while men's resource level had little effect.

3. Sustainable bean production systems

Our milestones this year were focused in this output – in catalyzing farmers to start adopting new agronomic practices including use of green manures. Participatory diagnosis of soil fertility in a long-term pilot site in Uganda showed that only 3.5% of households are currently applying most soil fertility management practices, and 86% were taking no measures. However, even this low level of adoption reflected positive impact of earlier work with our partners. In evaluating options from trials, farmers looked for simple fertility-improving technologies that require little labor and only inexpensive, locally available resources.

In adapting our earlier Ugandan results with dual purpose fodder and soil improving legumes, Ethiopian farmers started experimenting with seven species; farmers liked canavalia as the best producer of biomass, although trifolium and stylosanthes looked promising as these species rejuvenated well after cutting. Short-term experimentation with varieties and other simple technologies provided good entry points to sustain farmer participation, but investment is still needed in the quality of participation and identifying entry points and trade-offs to move further into NRM research agenda.

Farmer research groups (FRGs) proved effective at reaching people often neglected by formal research and extension services. In Uganda, women constituted 67% of membership in mixed groups as well as forming some separate groups. The performance and resilience of FRGs has been mixed, and we are now learning why: the most effective groups tend to be small, with committed leadership, in communities committed to collective action, and have broadened the scope of their activities well beyond research and experiments. Support from a researcher with unusual commitment also proved an influential factor.

4. Technology adopted

The number of requests for assistance in designing decentralized seed production interventions in Eastern and Southern Africa increased significantly. A framework for monitoring and evaluating decentralized seed production activities was developed and tested with partners.

IPM was successfully disseminated in a pilot trial through a decentralized approach. Participatory extension helped farmers to understand complex crop and pest problems and decide on management strategies, and caused them to want to tell others about what they learned in research groups. Farmers were interested to contribute their own treatments, and locally available botanicals proved to be effective in protecting grains in storage.

Market surveys in northern Tanzania, which supplies some of East Africa's largest urban centers, showed that Lyamungu bean varieties, widely disseminated 10 years ago as a little known grain type in that area, had gained 2nd and 4th places in market share. Presenting the evidence of bean impact achieved through improving farmers' access to a wide range of cultivars helped East African institutions reach sensitive decisions on harmonizing national seed policies.

A strategic study of the effectiveness of seed aid after drought in Kenya showed that, for their main crops of maize and beans, small farmers routinely rely on local markets for a significant proportion of their seed. Seed aid generally treats a symptom, and perhaps not in the most effective way. Those who received seed aid once were not necessarily less likely to receive it again: amounts given were not significant in the context of farmers' overall seed procurement strategies. In semi-arid areas, farmers chronically short of their own home-saved seed and chronically sort of cash to top off stocks with market purchases might be better off with open pollinated varieties or vegetatively propagated crops. Chronic stress also demands a more holistic seed system support approach, beyond issues of seed and variety.

Progress Report 2000

Output 1. Stronger networks in Africa linking NARS, IARCs, NGOs and the private sector

Activity 1.1 Develop new partnerships within regional networks

Achievements:

- The ECABREN enthusiastically developed a new research framework based on market characterization in participating countries. Private sector and social science participated in network planning.
- On the basis of comparative advantage, ECABREN was given leadership in participatory research and farming systems (intercropping) in the ASARECA region, in collaboration with other networks and projects.
- In novel partnership approaches to decentralizing regional bean breeding in networks, two new regional positions, replacing one international position, were filled by the most experienced bean breeders from ECABREN and SABRN, both remaining at their national institutional bases and in one case being a joint appointment with the University of Nairobi.

New partnerships within the ECABREN network

Rationale: Technologies developed by research institutions will create impact on rural and urban populations only if relevant research and non-research institutions, farmers and the private sector work together in their development and dissemination. Countries within the ASARECA region differ in their recent history in achieving research impact, in part due to partnership differences, and the Network is well placed to catalyze their strengthening.

Methods: The ECABREN Steering Committee (SC) funded initial studies on characterization of bean markets in participating countries. A planning meeting gathered national coordinators, working group leaders, CIAT staff and donors to analyze country reports on bean markets. A subsequent special planning meeting was convened to finalize a new framework defining outputs, goals, benchmarks, and research activities to achieve the desired outputs. ASARECA also convened a workshop to share responsibilities and avoid duplication among networks.

Results and discussion: For the first time, the annual SC meeting widened the composition of the steering committee to include the private sector, represented by a bean exporter from Madagascar, social scientists, and invited the SABRN network coordinator. The inclusion of the bean exporter was important to learn more on market constraints and opportunities for beans at regional and international level. The enthusiasm shown by participants from different institutions working to improve bean channels confirms the importance of partnerships in implementating projects to improve bean quality and quantity in ASARECA's commercialization drive to increase incomes and alleviate poverty of small farmers.

The new framework focuses on 7 market classes for local, regional, and international markets, and includes a perspective from technology development to marketing. This model emphasizes team spirit and partnerships with all potential NARS institutions, including universities, farmers' associations, private sector/companies, and NGOs. Promoting technology is a special need among the options explored for the network.

ASARECA distributed cross-cutting research and training coordination tasks among networks, programs and projects, based on their comparative advantage. ECABREN was given regional responsibilities for carrying out and/or convening research activities on farming systems, especially intercropping, and on participatory approaches and techniques in collaboration with other networks.

The SC approved no research proposals during its annual meeting due to lack of adequate market characterization in participating countries on which to base future research. However, ongoing research sub-projects approved last year were refunded pending their possible reformulation to fit the new framework. Twenty-four subprojects, however, were considered as completed (Table 1); followup or dissemination aspects of these projects will require new proposals that address market strategy. ECABREN should be able also to catalyze access to other and larger sources of funds for dissemination activities beyond the remit of the Network, while ECABREN focuses on small scale dissemination in partnership with small farmers.

Contributor: M. Pyndji
Collaborators: ASARECA; NARS, SC members and scientists from Burundi, DR Congo, Ethiopia, Kenya, Madagascar, Rwanda, Sudan, Tanzania, and Uganda

Innovations within the southern Africa network

The Southern Africa Bean Research Network (SABRN), which currently has 9 active country members within SADC, started to operate from Malawi at the beginning of 2000. The Government of Malawi provides office, laboratory and field research facilities at Chitedze Agricultural Research Station, while the Southern Africa Center for the Coordination of Agricultural Research and Training (SACCAR) provides operational funds from its African Development Bank (AfDB) grant. CIAT, through the Pan-African Bean Research Alliance (PABRA), provides support to the network by funding the coordinator's position and some pan-African activities across the two networks. As such, this network arrangement reflects a true partnership among various stakeholders. The coordinator's position, which was competitively recruited from the region last year, is 50% coordination and 50% breeding for the network, including germplasm exchange. The coordinator is supported by national program scientists, in Malawi and other countries. CIAT staff from Africa and Headquarters provide backstopping.

This network has been constrained in recent years by lack of a special project donor. However, SACCAR has maintained the network by supporting a core set of research sub-projects over the past years, increased in 1999 to cover operational costs for the coordinator (Table2).

Table 1. Regional sub-projects likely to be completed in 1999-2000.

Sub-project title	Country	Institution/Station
Effect of nematodes and bean stem maggot on Fusarium wilt	DR Congo	INERA Mulungu
Genetic diversity at farm level	DR Congo	INERA Mulungu
Field management of the storage bruchid, *A. obtectus*	Uganda	NARO Kawanda
Population dynamics and resistance to bean stem maggot	Kenya	KARI Katumani
Leaf beetle epidemiology	Uganda	NARO Namulonge
Apoderus effect on seed yield	Madagascar	FOFIFA Antananarivo
Adaptation of climbing beans in eastern and central highlands	Kenya	KARI Embu
Adaptation of climbing beans in Kagera region	Tanzania	DRD/MARI Maruku
Adaptation of climbing beans in Kilimanjaro region	Tanzania	DRD Selian
Climbing beans for southern Ethiopia	Ethiopia	EARO Awassa
Promotion of climbing beans: Calliandra stakes and farmers	DR Congo	INERA Mulungu
Production and use of stakes for climbing beans	Rwanda	ISAR Rubona
Selection of climbing beans for participatory plant breeding	Rwanda	ISAR Rubona
Eliciting food bean preferences in Areka, southern Ethiopia	Ethiopia	EARO Areka
Evaluation of preferences of urban consumers in Kampala	Uganda	NARO Namulonge
Adoption studies of new bean varieties	Madagascar	FOFIFA Antananarivo
Diffusion of improved bean varieties	Rwanda	World Vision Rwanda
Development of bean flour	Uganda	NARO/FSRI Kampala
Biological fixation of nitrogen	Burundi	ISABU Bujumbura
Improved utilization of local materials in soil management	Uganda	NARO Kawanda
Using household wastes for bean utilization	Burundi	ISABU Moso
Effect of lime and rock phosphate	Rwanda	ISAR Rubona
Green manures for sole and associated bean crops	DR Congo	INERA Mulungu

Additional activities on bean research in the region are carried out through the University-led research program funded by the United States Agency for International Development (USAID) through the Bean-Cowpea Collaborative Research Support Program (CRSP), which took responsibility for drought research in the region.

Despite the low level of funding, at least two varieties (CAL 143 and A 197) distributed through regional trials are now in demand by small-scale farmers in Malawi, Zambia and Angola, where they have been officially approved. Two other CIAT-bred varieties, A 286 and A 344, are popular in Angola and Malawi. Large quantities of all four varieties have been supplied to farmers in Angola through the Seeds of Freedom project (led by ICRISAT). Malawi is now seen as a regional role model for its seed promotion and dissemination strategy, with a radio and poster campaign that has created demand for sale of seed of new varieties in small packs, totalling over 110 tons since 1996. The majority of these farmers were satisfied with the new varieties, and are interested in purchasing more. Merchants who have participated in the scheme are enthusiastic and wish to continue. A visit by program leaders of bean research in Swaziland and Zambia to the seed multiplication programs in Malawi assisted the two countries to institute similar programs; Tanzania, Mozambique, Zimbabwe and Angola have also shown interest in such *initiatives*.

Tanzania has documented the greatest impact so far from use of new bean varieties, where they are being widely consumed even in urban areas. More recent information will be generated when proposed impact studies in Malawi and the southern highlands of Tanzania are carried out. Revised regional priorities, established by the Network and reported in 1997, have been fully effected. As the network's sub-projects are more in the biological sciences than in social sciences, priority now is on increasing social studies on technology transfer, adoption and impact assessment.

Contributors: R. Chirwa and R. Kirkby
Collaborators: SACCAR; NARS, SC members and scientists from Angola, Lesotho, Malawi, Mauritius, Mozambique, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe.

Table 2. Regional research sub-projects implemented by SABRN countries in 1995-2000.

2a. *Old sub-projects*

Title	Country	Institution	Start
Breeding for tolerance to drought	Tanzania	SUA	1995
Breeding for bruchids resistance	Tanzania	SUA	1994
Dissemination of new varieties	Lesotho Malawi Mozambique Tanzania	MoA Maseru DARTS Chitedze INIA ARI-Selian	1995
Pathogenic variation of rust	South Africa	ARC/GCRI	1995
Bacterial diseases	South Africa	ARC/GCRI	1995
Physiological races of angular leaf spot	South Africa	ARC/GCRI	1995
First and secondary multiplication of two varieties	Angola	MoA	1997
Evaluation for BSM resistance in Southern Highlands	Tanzania	ARI-Uyole	1997
Ootheca management in Southern Highlands	Tanzania	ARI-Uyole	1997
Mass rearing for resistance breeding against BSM	South Africa	ARC/GCRI	1997
Dissemination of new bean varieties	Zambia	MoA	1997
Farmer participation in selection / seed multiplication	Zambia	MoA	1997
Beanflies and bean insects	Malawi	DARTS-Chitedze	1996
Screening germplasm for drought tolerance	Malawi Tanzania (CRSP)	Bunda College SUA, ARI-Uyole	1997
On-farm seed multiplication	Swaziland	MoA	1998
Farmer oriented decision guide to soil fertility	Tanzania	ARI-Uyole	1998
Farmer based selection of elite multiple resistant lines	Tanzania	ARI-Uyole	1998
On-farm evaluation of bean genotypes	Lesotho	MoA	1998

NB: Due to luck of funding some of the sub-projects may not have been carried out.

2b. *New sub-projects*

Resources for integrated nutrient management in Southern Highlands	Tanzania	ARI-Uyole	1999
Evaluation of advanced progenies	Tanzania	ARI-Uyole	1999
Race identification and breeding for resistance	South Africa	ARC-GCRI	1999
Angular leafspot race identification and breeding	South Africa	ARC-GCRI	1999
Selecting multiple resistant lines for diseases and BSM	South Africa	ARC-GCRI	1999
Screening bean lines for low soil fertility	Malawi	BIP	1999
Organic and inorganic fertiliser on maize/bean cropping systems in medium altitude areas	Malawi	BIP	1999
On-farm seed evaluation and dissemination seed	Malawi	BIP	1999
Bean germplasm with multiple constraint resistance	Malawi	BIP	1999
Potential of crotolaria as a green manure for bean	Swaziland	MoA	1999
Screening genotypes for maturity and soil stresses	Lesotho	MoA	1999
Verification of bean IPM strategies with small farmers	Mozambique	INIA	1999
On-farm diagnosis of plant nutrition constraints	Mozambique	INIA	1999
On-farm evaluation of promising climbing bean lines	Zambia	Misamfu	1999

Activity 1.2 PABRA members coordinate and take greater responsibility for managing regional networks

Achievements:

- The bean networks have started deliberately seeking synergies through combining strategies for decentralised seed enterprises, empowerment of entrepreneurial farming communities in sharing research responsibilities, and linking research with demand in more sustainable ways.

An integrated PABRA strategy linking communities, empowerment and market demand

Rationale: The ECABREN and SABRN networks are self-governing under the policy direction of ASARECA and SABRN, their respective regional NARS organisations, with CIAT being an active member of each grouping. Many important constraints and opportunities occur across the boundaries of each network, and efficiencies can be expected from well coordinated activities.
While coordination used to be mediated by CIAT, this is not a sustainable or desirable arrangement now. Also, the stronger NARS are in a position to undertake some of the strategic research otherwise expected of CIAT, a shift that is reducing costs substantially.

Methods: The fourth Annual Meeting of the steering committee of the Pan-Africa Bean Research Alliance (PABRA), in Mzuzu, Malawi in May 2000, again brought together representatives of the two networks, CIAT and principal donors to bean research in Africa. A main agenda item this year was the future strategy for the set of closely linked projects and activities that together contribute the outputs of PABRA.

Results and discussion: CIAT and national network members in unison, as the implementing institutions, viewed the new priorities of PABRA — and of its main donors — as being highly complementary. With widespread impact from bean research now demonstrated at household and national levels, especially in Central and Eastern Africa, network members have started to put much more deliberate effort into understanding, developing and building on market demand beyond the purely local level. Priority to breeding for seed types that have the largest market share is an example. At the same time, investing in bean-producing communities that have already adopted some new technologies – to ensure that benefits reach women and the poor—is seen as a measure with considerable untapped potential. By shifting research costs more sustainably towards the intended users (through participatory research), increasing demand by reaching more rural communities (promotion and empowerment that scales up the demand) and through creation of small farmer enterprises (starting with seed systems), overall impact is expected to be much higher and its distribution more equitable.

The synergies are more important than the possible conflicts, although awareness of both is needed. Decentralised seed enterprises selling new varieties locally at a premium price, for a crop that is rarely of commercial interest even in more prosperous regions of the World, can be a motor for investment by entrepreneurial communities or groups in their own research capacity, while they also increase the overall demand for private sector suppliers of basic seed. Wider adoption of higher yielding varieties also needs to drive farmer investment in their natural resource base, rather than being a reason for temporarily postponing their day of reckoning.

Activity 1.3 Technical support and participation in network training, information and planning

Achievements:

- A preliminary characterization of bean markets was carried out by the nine ECABREN countries, and a pilot course in business skills benefited 22 bean farmers from Tanzania.
- Female technicians from Rwanda, which continued to provide climbing bean varieties to the region, received training at CMRT and at CIAT Kampala.
- Training in gender and stakeholder analysis for watershed management and in indicators of soil fertility was organized by PRGA and CIAT Hillsides Project in support of research in five countries under the Africa Highlands Ecoregional program (AHI) and the Soil and Water Nutrient Management (SWNM-TSBF) program.

Workshops, monitoring, and training by ECABREN and SABRN

Rationale: Some countries in the network still need support in capacity strengthening and management skills to ensure the implementation of their research programs; a few do not have national research strategies oriented to achieving impact. At the other end, many users of technologies developed by network members lack business skills for income generation.

Methods: The network supported national bean programs and partner institutions in organizating business awareness and management skills for a pilot group of farmers, short course training, and a national strategic planning workshop for Madagascar. To strengthen capacity of national scientists to monitor research activities in ECABREN and SABRN regions, the networks jointly arranged a tailored course on monitoring and evaluation from MS-Training Centre for Development Cooperation (TCDC) in Tanzania.

Results and discussion: In cooperation with FAIDA-SEP (Finance and Advice in Development Assistance for Small Enterprise Promotion), ECABREN sponsored a three-day business awareness-training pilot course for Makiba farmers' groups in northern Tanzania at their request. Production and especially market problems mentioned by farmers included: a) no market outlet for crops, b) roads unreachable during heavy rains, c) poor prices for crops, d) lack of working capital, e) unavailability of water for irrigation, and f) lack of knowledge of good farming practices. The trainers showed farmers that all these problems were within their power to solve. Topics discussed during the course included qualities of an entrepreneur, business environment, contract farming, crop production analysis and group saving. Despite farmers' enthusiasm for the course, the groups did not seem to be cohesive in their objectives, and appeared weak in leadership. A recommendation was to assist these groups in identifying reliable markets for their cash crops, though a market survey to improve knowledge of channels and how best to enter these markets. This short course is seen as a pilot for catalyzing business awareness in the region within market-led research strategy.

Strengthening the human capacity of Rwanda's Bean Program has been an ECABREN pre-occupation since 1994. This year, two female technicians (from the University of Rwanda and ISAR Rubona) were trained in laboratory techniques at CIAT Kampala and in bean crop production aspects at CMRT, Egerton University, respectively. This will help restore the capacity of Rwanda to serve as the main provider of improved climbing beans to other countries.

ECABREN is in the process of developing a website for making itself better known in the region and internationally. This is possible following a short training course sponsored by ASARECA.

Contributor: M. Pyndji
Collaborators: CIAT, SABRN, ASARECA, CMRT, FAIDA-SEP, MS-TCDC.

Capacity building in participatory research, gender and stakeholder analysis

Rationale: Participatory research, gender and stakeholder analysis (PR&GSA) methodologies are relatively new to most NARS partners, and few have experience in using participatory research processes beyond PRAs. Methodologies, tools and skills for social analysis are badly lacking. Building capacity through training, workshops and site visits is central to augmenting skills in social science and participatory research.

Method: Regional and in-country training workshops were organized by AHI to build the research capacity of its NARS collaborators. IARCs scientists and research fellows provided scientific backstopping to selected sites on thematic areas.

Results: We conducted three training workshops, and made four backstopping visits to AHI sites and PRGA NRM small grants.

Workshop on gender and stakeholder analysis tools for watershed management

The two-week training workshop was organized by the PRGA programme and CIAT Hillsides programme in collaboration with the Africa Highlands Ecoregional programme (AHI), and the Soil and Water Nutrient Management (SWNM-TSBF) programme. A total of 18 participants (6 women and 12 men) from AHI benchmark sites and collaborating institutions in five eastern African countries (Madagascar, Ethiopia, Kenya, Tanzania and Uganda) attended the workshop on GSA tools for watershed management.

Workshop participants developed action plans for incorporating PR&GSA concepts, tools and methodologies into their current or/and future activities, including specific steps and strategies for sharing information with other site team members. In-country follow up worskhops and backstopping visits were undertaken in Ethiopia, Kenya, and Madagascar.

Participatory monitoring and evaluation (PM&E) workshops

Two PM&E workshops were conducted for AHI teams in Ethiopia (20 participants) and Madagascar (25 participants, 4 women). The topics covered included: (i) interdisciplinary team building, (ii) partnership and collaboration, (iii) participatory research, (iv) stakeholder analysis, and (v) participatory monitoring and evaluation. Action plans were developed to integrate PM&E in the research process. Performance assessment framework with focus on participatory process and resulting outcomes to farmers, researchers and research teams were developed.

Contributor: P. Sanginga (CIAT/PRGA).
Collaborators: AHI and partners.

Activity 1.4 Efficient modes of managing networks

Achievements:

- Two regional NARS scientists monitored and evaluated BILFA and PRIAM research in five ECABREN and SABRN countries, responsibilities that until last year were undertaken by CIAT international staff.

Regional resource persons used by the networks in technical support and monitoring

Rationale: Regional networks need to be cost-effective, achieving good cross-country spillovers at acceptable costs for management and other transactions.

Methods: Two of the best performing PABRA working groups have been in bean improvement for low fertility in Africa (BILFA) and in Participatory Research for Improved Agro-Ecosystem Management (PRIAM). The networks with PABRA funding empowered the leaders of these groups to start providing support and monitoring services to collaborating scientists and countries.

Results: The leading scientists, from INERA (DR Congo) and FOFIFA (Madagascar), visited and reported on progress, needs and future direction for these cross-country research activities in Ethiopia, Kenya, Rwanda, Tanzania and Uganda. To encourage this initiative further and empower the NARS to take responsibility of monitoring and evaluating other regional collaborative activities, ECABREN, SABRN, and CIAT agreed tc organize a monitoring and evaluation course for network coordinators, national coordinators, and working group leaders responsible for evaluating research progress in the two networks.

Contributors: R. Kirkby
Collaborators: M. Pyndji (CIAT/ECABREN), R. Chirwa (CIAT/SABRN)

Activity 1.5 Refine characterization of bean growing environments using biophysical and socio-economic data

Achievements:

- A more explicit gender strategy was developed for CIAT-PABRA.
- Bean production systems by male and female headed households in the Central Rift Valley of Ethiopia better understood.
- Farmers in South-western Uganda clearly identify and recognize bean root rots but do not distinguish between root rots and bean stem maggot.

Gender strategy for CIAT-PABRA (IP-2)

Rationale: Gender has been a central concern in CIAT's research, technology dissemination and capacity building activities in Africa, although we have not pursued an explicit gender strategy. We maintain that gender analysis (approaches to understanding differences and similarities between men and women in terms of needs, interests, access and impact of changes and interventions) and the involvement of both women and men are central to technology development and dissemination generally, and even more so in the case of food crops. A gender strategy will help ensure that CIAT's activities in Africa are responsive to the needs and demands of all categories of rural people, especially women and the poor who tend to be overlooked or excluded.

Methods: A strategy was drafted on the basis of earlier ones developed by the bean networks with support from CIAT's regional sociologist and a consultant. The draft was modified and a final strategy agreed collectively at the annual IP-2 staff meeting.

Research and discussion: The gender strategy addresses five outputs: characterization, monitoring and evaluation, technology development and testing, technology dissemination, strengthening NARS and enhancing CIAT-PABRA's capabilities (Tables). The thrust of the strategy is to achieve full participation of all categories of technology users and beneficiaries in technology development, testing and dissemination.

Contributor: S. David.
Collaborators: All IP-2 staff.

Table 3. Gender specific activities within the Pan-African Bean Research Alliance (PABRA).

PABRA outputs	Gender-specific activities
Characterization, monitoring and evaluation	Incorporate gender analysis in characterization of target environments
	Document indigenous technical knowledge with attention to gender differences in knowledge systems and transmission of knowledge
	Disaggregation of data by gender with regard to user preferences, adoption and impact of technologies, dissemination approaches
Technology development and testing	Setting priorities for technology development (ex ante) at research institute/station level
	Use of participatory research methods to involve diverse groups of stakeholders
	Promote forms of farmer organizations that facilitate women's involvement in research
	Take advantage of, and build on, indigenous technical knowledge
	User group targeting in participatory activities, including participatory plant breeding
	Select test methods appropriate for both women and men
	Inclusion of gender, as well as other socio-economic characteristics, as a criterion for selecting trial farmers
Technology dissemination	Conduct action research to develop extension methods appropriate to women and other frequently excluded stakeholders
	Support NARS and NGOs to develop extension materials appropriate to women and other frequently excluded stakeholders
	Introduce a gender perspective in understanding and promoting farmer-to-farmer extension approaches
	Design farmer-based seed production systems appropriate for both female and male farmers
Strengthening NARS	Support to Networks and NARS (refer to Networks' gender strategies)
	Maintain a gender balance in the recruitment of students
Enhancing CIAT-PABRA capabilities	Offer regular gender sensitization training to international staff
	Staff required to indicate gender implications of proposed research activities on annual workplans, where relevant
	Diversification of staff by gender and region

Gender as a factor in the bean production system in the Central Rift Valley of Ethiopia

Rationale: It is well known that men are the principal farmers in Ethiopia and Sudan, in contrast to other parts of sub-Saharan Africa. However, little is known about the role of women in agriculture in those countries, as wives or heads of households in their own right, and what their role is in agriculturally related decision-making. This information is crucial for technology development and dissemination in those countries.

Methods: One hundred and sixty households in the Boffa area of the Central Rift Valley of Ethiopia (where PRIAM participatory research is also in progress) were interviewed during a formal survey. Households were stratified by the sex of the head and number of wives, and forty households were randomly selected to represent four household types types: male headed, one wife; male headed, multiple wives; landless male headed; and female headed.

Results: Compared to male headed households, households headed by women had fewer resources, namely labor, oxen and land. In an area where beans are cultivated mainly as a cash crop, female headed households were somewhat less like to grow beans (57% compared to 75% of male headed households with one wife) but, on average, allocated a higher proportion of their cropland to beans (0.4 *kert* compared to 0.3 *kert*). Only 4% of surveyed households grew colored varieties which are mainly used for home consumption. Due to their smaller household sizes, female headed households were more likely not to weed (74% compared to 27% of monogamous male headed households) and not to sort seed (83% compared to 50% of monogamous male headed households). Nevertheless, there were no statistically significant productivity differences by the sex of the household head. A more detailed analysis of data from this study is expected.

Contributors: Dawit Alemu (EARO); S. David.

Farmers' indigenous technical knowledge of bean root rots in South-western Uganda

Rationale: An understanding of the richness of local knowledge systems can guide research, development and extension activities. Existing farmer practices and knowledge should be used as the starting point for integrating the best of local and modern technologies. Yet, relatively few studies on indigenous knowledge of plant diseases have been carried out and, in the case of bean diseases, have not focused on the increasingly problematic root rots. Information on farmers' practices to control root rots and their understanding of the disease will be used to guide and develop research and extension activities undertaken by a new DFID funded bean root rot disease control project.

Methods: In February and April 2000, participatory rural appraisal methods were used in two communities to elicit information on the farming system, crop production constraints, gender division of labor, bean production, and farmer perceptions of bean root rots and its relationship to soil fertility. The two main study communities were Kafunjo and Karambi Parishes of Kabale and Kisoro Districts, respectively, in south-west Uganda. A more detailed study is being undertaken by an MSc student from Makerere University.

Results: Farmers in Kisoro ranked root rots (*runiga* or "suicide") as the most important production constraint for beans. In Kabale, aphids and lack of new varieties were the most important problems. In diagnosing root rots, most farmers only look at above-ground symptoms and therefore confuse symptoms of root rots and bean stem maggot. Farmers reported that root rots occur during both the rainy season and dry periods, although they are more severe during periods of high rainfall. The disease is considered to be more severe on hilltops than in valleys and does not occur on fertile soils. In both districts, declining soil fertility was associated with an increase in bean diseases generally. Perceived causes of root rots include: overcultivation, poor soil fertility, late planting and insect pests found on the roots of affected plants.

Farmers used various measures to control root rots including crop rotation, use of compost/manure and growing tolerant varieties. One traditional control measure was to uproot diseased plants and dump them in the lake while chanting "*kuka runiga*" (root rots disappear). Farmers practice fallowing and rotation only to a limited extent due to land shortage.

Contributors: E. A. Lubega, G. Tusiime, J. Mukalazi (Makerere University); S. David, R. Buruchara.

Output 2. Germplasm with relevant traits developed and used widely in Africa

General rationale: Over the past two decades NARS have made intensive use of introduced lines in breeding and constraint nurseries from CIAT, Colombia (now Project IP-1), which have provided 95 (59%) of 162 cultivars released by NARS from the 1950s to 1998. NARS, regional networks and CIAT have agreed that sustaining the impact from bean research will require stronger crossing programs by key NARS that have the necessary manpower resources. The regional networks need to better coordinate their support across countries to ensure that national efforts are as complementary as possible, while taking greater ownership of African regional breeding programs under IP-2 that supply NARS with inputs well targeted to principal African constraints.

Activity 2.1 Targeting of bean germplasm

Achievements:

- The regional bean networks reorganised their variety development to include 7 priorities market classes, with regional leadership responsibilities decentralised to national programs.
- Half of the 33 *P. griseola* isolates from southern Tanzania, and Ethiopia are of the Afro-Andean pathogen group, an increasing evidence of its importance in Africa. Two isolates from Tanzania infected Mex-54, which is resistant to almost all isolates from Africa characterized so far.
- Molecular studies based on microsatellites differentiated isolates of *P. griseola* from varietal mixtures, in groups, that varied within them. Correlation with variation in virulence and implication for pathogen diversity is yet to be determined

New breeding strategy for Africa

Rationale: Greater emphasis on a market-led approach to generating and sharing genetic diversity is now appropriate because the importance of farm sales of this crop have continued to expand in response to demand from local, regional and international markets and our stakeholders are increasingly organising their research by market priorities. As preferences for bean types differ greatly across Africa and across kinds of market, many varieties are needed to meet this diversity. The size of markets differ also: for example, red seeded and red mottled types account for about 50% of production in eastern and southern Africa, while black seeded types account for only 3%. The purpose of this activity was to develop and implement a new regional breeding program that better responds to these needs.

Materials and methods: Coordinators of national bean programs in the Eastern and Central Africa were requested to conduct market surveys to update their knowledge of the main market classes and their respective production constraints. Data from these surveys and other sources served as the basis for developing new programs in consultation with regional and CIAT scientists and donors to bean networks in Africa.

Results and discussion: Ten programs were developed for implementation by the networks. Seven are cultivar development programs for the most important market classes (Table 4). For each class selected (purples and blacks were deemed of low priority), breeding objectives and methods, main outputs, targets and progress indicators were identified. Germplasm requirements and sources to meet breeding goals are also stated. Responsibilities among collaborating partners (CIAT, NARS, farmers, NGOs and other stakeholders) are identified. Program 9 was developed to support those breeding activities by creating source nurseries for important traits and to improve old cultivars. Program 10 cuts across market classes to provide breeders' seed of improved cultivars for further formal or informal seed multiplication and dissemination, as well as focussed research activities in germplasm-related agronomic and socio-economic issues. To decentralize the breeding activities, each collaborating national program identified one program among the market classes (Programs 1-9) having enough national importance for the country to offer regional leadership and commit resources, and others where it wishes to collaborate (Table 4). The new initiative is already being implemented in Ethiopia, Rwanda and Uganda and is expected to be fully operational by June 2001. A back up program will be based at the regional breeding centers in Kenya and Malawi.

Contributors: P. Kimani, R. Chirwa, P. Mukishi and R. Kirkby
Collaborators: M. Blair and S. Beebe (IP-1).

Virulence characterization of pathogen diversity of *Phaeoisariopsis griseola* in Africa

Rationale: Use of host resistance is an effective strategy for poor resource farmers against angular leaf spot (ALS), Africa's most damaging bean disease, caused by *Phaeoisariopsis griseola*. But occurrence of pathogen variability in the pathogen can adversely affect the effectiveness of resistance. On-going research based on virulence and molecular characterization of African isolates show occurrence of Mesoamerican, Andean and Afro-Andean pathogen groups. Most countries where ALS is a problem lack adequate information about the genetic structure of *P. griseola* and distribution. In designing and developing durable resistance characterizing pathogen variability and its distribution is important.

Methods: Isolates were characterized from the important bean growing areas in Tanzania (southern highlands and northern region) and Ethiopia (Jima) not previously assessed. A total of 35 isolates were characterized using virulence on the basis of a set of 12 bean angular leaf spot differentials (6 Andean and 6 Mesoamerican).

Results and discussion: Twenty-three isolates from southern Tanzania belonged to 14 races, three from northern Tanzania belonged to three races, while seven from Ethiopia belonged to 7 races — an indication of the wide pathogenic variation common in *P. griseola* (Table 5). About a half of all isolates gave reactions associated with the Mesoamerican pathogen group, while another half gave a reaction associated with the Afro-Andean group. Two gave reactions associated with the Andean pathogen. It is interesting to note that two isolates infected Mex 54

Table 4. Bean market classes, production and priority constraints for breeding in Africa.

Market class and program	Production (ha)	Priority constraints [1]	Program lead countries (and collaborators)
1. Red mottled	740,000	ALS, Anth/RR, low P, BSM	Uganda (Kenya, DR Congo, Tanzania, Sudan, Malawi, Sudan, Zimbabwe, Cameroon)
2. Reds			
a. Large red kidneys	350,000	ALS, Anth, low P, BSM	Tanzania (Kenya, Tanzania, Malawi, Zimbabwe)
b. Small and medium reds	670,000	ALS, Anth/CBB, low P, BSM	Ethiopia (Rwanda, Burundi, Kenya, Uganda, Tanzania, DR Congo, Lesotho, Zimbabwe)
7. Browns a. Yellow b. Brown c. Tan	380,000	ALS, Anth/CBB, RR,low P	DR Congo (Angola, Tanzania, Kenya, Madagascar, Sudan, Zambia, Zimbabwe, Lesotho)
3. Cream a. Pinto b Sugars cranberry c. Carioca	360,000	ALS,CBB/rust, low P	Kenya [pinto]; DR Congo [sugar]; Ethiopia [carioca]. (Angola, South Africa, Kenya, Uganda, Zambia, Zimbabwe, Lesotho)
6. White			
a. Navy	310,000	Rust, ALS, CBB,BSM	Ethiopia (South Africa, Malawi, Kenya, Uganda, Tanzania, DR Congo)
b. Large white kidney	220.000	ALS, Anth, low P	Madagascar (Tanzania, Zambia, South Africa, DR Congo)
Purples	270,000		Tanzania? (Kenya, Zambia, Madagascar)
Blacks	130,000		Uganda? (Ethiopia, Sudan)
4. Climbers		Anth., ALS, RR, low P	Rwanda (Burundi, DR Congo, Kenya, Uganda)
5. Snaps a. Bush b Climbers c. *P coccineus* climbers		 Rust, RR, ALS Anth,RR, ALS	Uganda [bush]; Kenya [climbers] (Tanzania, Zambia, Zimbabwe, South Africa)

Note: [1] Anth = anthracnose; ALS = angular leafspot; RR = root rots; P = phosphorus; CBB = common bacterial blight; BSM = bean stem maggot; / indicates two constraints of equal importance.

(invoking an intermediate reaction). Mex 54 is the only differential which continues to maintain resistance to almost all races that have been identified so far in Africa. While Mesoamerican races occur both in Latin America and Africa, there is a very distinct group of Mesoamerican races, especially those that attack Mex 54, which are unique to Latin America but hardly found in Africa or vice versa.

Contributors: R. Buruchara; G. Mahuku (IP-1)

Collaborators: F. Mwalyego (DRD); Habtu Assefa (EARO).

Table 5. Virulence diversity of *P. griseola* in Tanzania and Ethiopia.

			Phenotypic reaction on differential cultivars[x]											
			Andean						*Mesoamerican*					
Isolate	*Origin*[y]	*Race*	*A*	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*K*	*L*
JM5	ETH	22-0		b	c		e							
UYL-1	TZA	63-0	a	b	c	d	e	f						
JM4	ETH	35-2	a	b				f		h				
UYL-9	TZA	62-5		b	c	d	e	f	g		i			
JM3	ETH	47-3	a	b	c	d		f	g	h				
JM1	ETH	40-6				d		f		h	i			
JM2	ETH	63-6	a	b	c	d	e	f		h	i			
UY-ILOMB	TZA	63-36	a	b	c	d	e	f			i			l
UY-CAL-1	TZA	63-36	a	b	c	d	e	f			i			l
UY-M54	TZA	63-37	a	b	c	d	e	f	g		i			l
UYL-11	TZA	63-37	a	b	c	d	e	f	g		i			l
Se3	TZA	31-7	a	b	c	d	e		g	h	i			
UY-AX-37	TZA	62-37		b	c	d	e	f	g		i			l
UY	TZA	63-38	a	b	c	d	e	f		h	i			l
Areka	ETH	47-35	a	b	c	d		f		h	i			l
UYL-18	TZA	62-22		b	c	d	e	f		h	i		k	
Se1	TZA	63-7	a	b	c	d	e	f	g	h	i			
UYL-14	TZA	63-7	a	b	c	d	e	f	g	h	i			
UYL-7	TZA	63-7	a	b	c	d	e	f	g	h	i			
Se2	TZA	31-23	a	b	c	d	e		g	h	i		k	
UYL-13	TZA	62-53		b	c	d	e	f	g		i		k	l
UYL-2	TZA	47-39	a	b	c	d		f	g	h	i			l
UYL-12	TZA	63-39	a	b	c	d	e	f	g	h	i			l
UYL-17	TZA	63-39	a	b	c	d	e	f	g	h	i			l
UYL-3	TZA	63-39	a	b	c	d	e	f	g	h	i			l
UYL-5	TZA	63-39	a	b	c	d	e	f	g	h	i			l
UYL-6	TZA	63-39	a	b	c	d	e	f	[illegible]	h	i			l
JM6	ETH	63-39	a	b	c	d	e	f	[illegible]	h	i			l
UYL-8	TZA	63-39	a	b	c	d	e	f	g	h	i			l
UYL-10	TZA	63-47	a	b	c	d	e	f	g	h	i	j		l
UYL-16	TZA	63-55	a	b	c	d	e	f	g	h	i		k	l
UYL-19	TZA	63-55	a	b	c	d	e	f	g	h	i		k	l
UYL-21	TZA	63-63	a	b	c	d	e	f	g	h	i	j	k	l

[x] CIAT *P. griseola* differentials: A = Don Timoteo; B = G 11796; C = Bolon Bayo; D = Montcalm; F = Amedoin; E = G 5686; G = PAN 72; H = G 2858; I = Flora de Mayo; J = MEX 54; K = BAT 332; L = Cornell 49-242.

[y] Origin of *P. griseola* isolates: ETH = Ethiopia; TZA = Tanzania.

Pathogen population structure of *Phaeoisariopsis griseola* in varietal mixtures

Rationale: *Phaeoisariopsis griseola* is a highly variable pathogen. Studies in Latin America have shown that *P. griseola* isolates from Andean varieties are virulent on Andean but not on Mesoamerican varieties, supporting the notion that the fungus has co-evolved with its common bean host. A similar situation seems to occur in Africa, except that there also occurs an Andean pathogen sub-group (Afro-Andean) that attacks some Mesoamerican varieties; this is thought to be due to the growing together of diverse germplasm belonging to the two Phaseolus genepools. In some African bean growing areas, varietal mixtures are grown but little is known of *P. griseola* pathogen population structure. Understanding the latter in these production systems is important in formulating management strategies for ALS in common beans.

Methods: Components of two bean varietal mixtures, one from Kisoro district in southwest Uganda and another from Rwandan germplasm collected under the Seed of Hope (SOH) program, were initially characterized for their seed and plant characteristics. Components of the Kisoro mixture consisted mainly of indeterminate, medium seed sizes and a variety of seed colors. The SOH materials consisted of mixture of determinate and semi-climber, large-, medium- and small-seeded types and a variety of seed colors. Fifteen components of each mixture were grown (as a mixture) in the field in Senge at Kawanda (Uganda). CAL 96, K20 and MCM 5001, all released varieties in Uganda, were included. DNA extraction was made on single spore cultures of isolates obtained from almost all the components grown. Good amplification was obtained and isolate differentiation was done using four microsatellite primers [(CA)n; (CGA)n; (GT)n; and (TG)n].

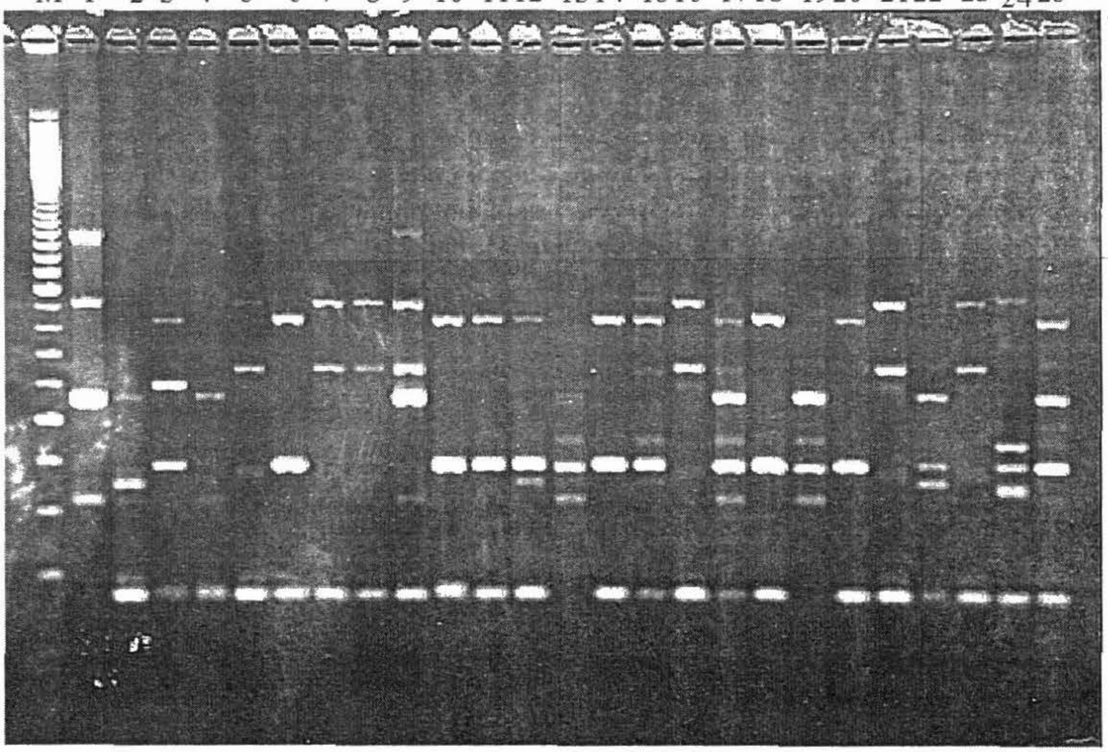


Figure 1. A picture of 28 isolates of *Phaeoisariopsis griseola* isolated from components of two varietal mixtures and three released varieties, based on microsatellites using the (GT)n primer.

Results and discussion: All cultivars had some infection but variation occurred in severity. Isolate differentiation using the (GT)n microsatellite primer is shown in Figure 1. A dendrogram exhibiting similarities of isolates based on combined data from all four primers used is shown in Figure 2. Results from the latter and from a multiple correspondence analysis show differentiation of isolates into four groups. The two isolates (3KW and 30KW) in one group came from components of the Kisoro varietal mixture, while five (12KW, 15KW, 31KW, 32KW and 35KW) out of 7 isolates in another group came from components of the SOH mixture. No pattern could be read with the other two groups. It was apparent that there are differences between and within groups. However, this variation needs to be correlated with variation in virulence to establish pathogen diversity patterns under conditions of such and similar germplasm diversity. This may in turn influence sampling techniques used in pathogen diversity studies in Africa and strategies in developing resistance under varietal mixtures conditions.

Contributors. R. Buruchara, S. Mayanja (IP-2); and G. Mahuku (IP-1)

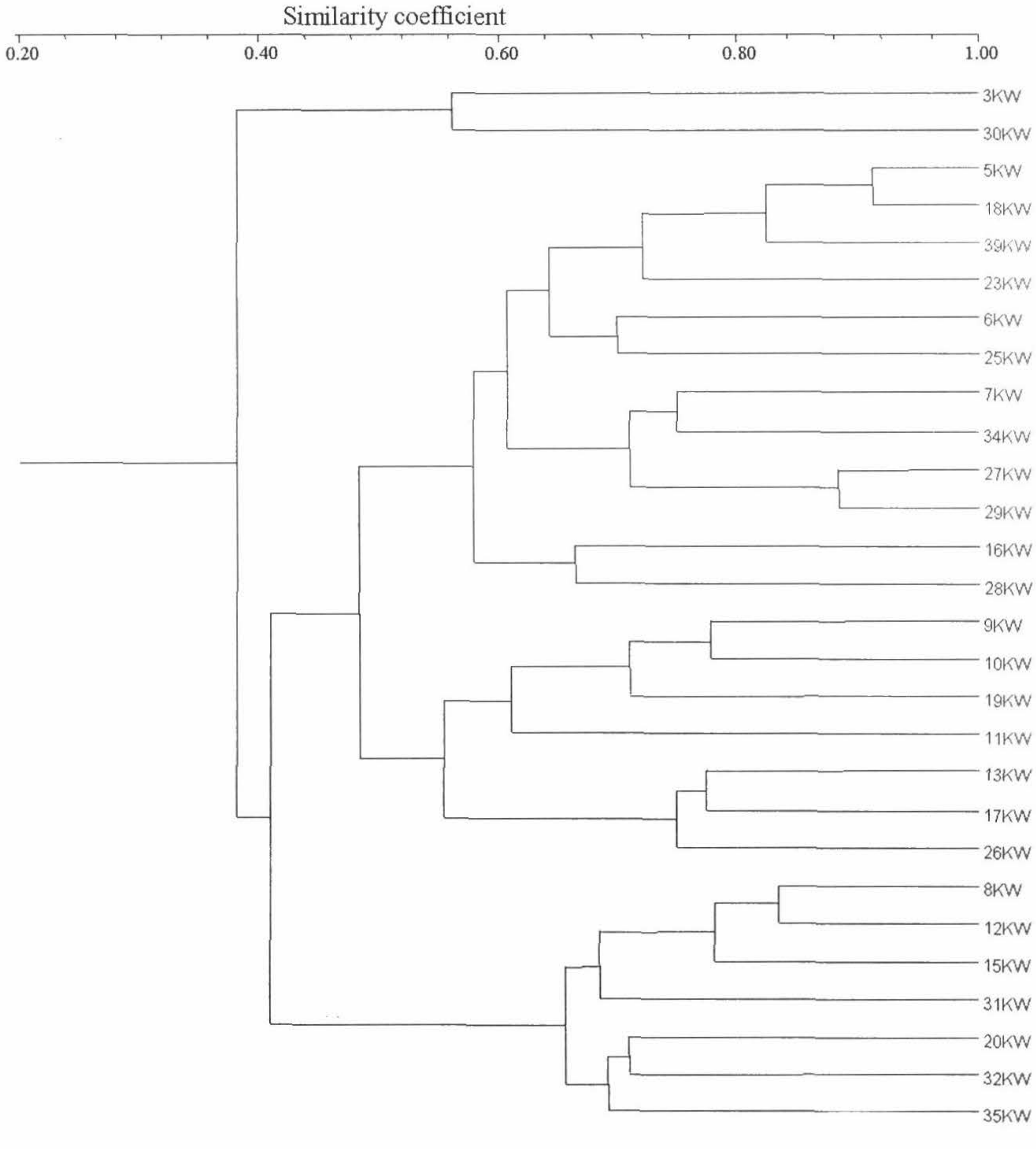


Figure 2. Dendrogram of 28 isolates of *Phaeoisariopsis griseola* from components of two varietal mixtures and three released varieties based on microsatellites using 4 microsatellite primers.

Activity 2.2 Germplasm to address African production constraints

Achievements:

- A new regional collaborative program for multiple constraints breeding identified lines of 12 market classes with tolerance to two or more biotic constraints.
- About 3.3% of 650 IBN and SOH entries screened against Pythium root rots gave intermediate reactions, while the rest were susceptible.
- Some entries in the IBN-96 nursery from IP-1 were resistant to separate mixtures of selected Mesoamerican and Andean races of *P griseola* from Africa.
- A good number of F_5 lines derived from crosses for multiple resistance gave promising results in evaluations against Pythium root rot.
- Shoot and root biomass were confirmed to be negatively correlated with severity of Pythium root rot and may be used as complementary parameters to assess resistance / susceptibility.
- NARS scientists identified additional good sources of resistance to stem maggot and tolerance to soil fertility constraints from CIAT germplasm and bred lines.

Multiple constraints market classes identified from segregating populations

Rationale: Bean producers in face numerous biotic and abiotic constraints, important biotic constraints occur in the same fields as low soil phosphorus and nitrogen and, consequently, improved varieties tolerant to a single constraint fail to maintain production stability. Traditional sequential incorporation of resistance genes into popular cultivars is a lengthy process. A regional multiple constraints breeding program was initiated to develop cultivars with resistance to at least two limiting constraints and marketable seed types for production by resource poor farmers.

Materials and methods: Focus was on the popular large red mottled, large seeded dark red kidneys, small and medium reds and cream seed types, and multiple resistance to combinations of angular leafspot, anthracnose, common bacterial blight, bean common mosaic virus, root rots and tolerance to low soil P, N and drought. Six multiple constraints nurseries (MCN) were created from single, three-way, double and complex crosses among selected parents of diverse origins.
Both intergene-pool and intra-gene pool crosses were made in IP-1 breeding programs at Cali (Colombia), and at Kawanda (Uganda) and Kabete (Kenya). The segregating populations were advanced to F_5 generation at Kabete under moderate pressure for anthracnose, angular leafspot and rust (F_2 and F_3), BCMV (F_4), and rust and drought (F_5). The F_4 and F_5 progenies were separated into priority market classes identified in the regional breeding strategy.

Results and discussion: Table 6 shows the number of $F_5.F_1$ derived lines of the 12 market classes with tolerance to two or more biotic constraints selected from the segregating populations during the short rain (October 99- Feb 2000) and long rain season (April-August 2000).

These preliminary results show that, while progenies of carioca seed types had the highest yield potential, considerable potential exists for further selection in most seed types. Selections with adequate seed will be distributed to collaborating countries for evaluation in preliminary yield trials and to confirm resistance to biotic and abiotic stresses. Further screening for angular leafspot, anthracnose and root rots will be carried out using artificial inoculations in the Kawanda screen house starting late in 2000.

Table 6. Yields of bean lines selected from segregating populations at Kabete, 2000.

Market class	Total entries	Selected progenies	Yield range (kg/ha)	Mean yield of selected progenies (kg/ha)	Network reponsibilities for further evaluation
Red mottled	927	227	121 - 4000	1873	Uganda
Red kidneys	872	253	347 - 3814	1740	Tanzania
Small/medium reds	103	82	390 - 3787	1615	Ethiopia
Navy	135	78	40 - 4185	1892	Ethiopia
Carioca	184	87	785 - 4734	2557	Ethiopia
Large white	129	5	691 - 2735	1326	Madagascar
Sugars/cranberry	435	59	410 - 3722	1923	DR Congo
Yellows/green	50	35	185 - 2963	1237	DR Congo
Brown/tan	355	109	267 - 4555	2265	DR Congo
Pinto	113	47	236 - 3761	1982	Kenya
Purples	491	327	108 - 3691	1520	open
Black	127	60	433 - 4000	2198	open

Contributor: P.M. Kimani (IP-2 and University of Nairobi).
Collaborators: ECABREN and national programs

Identification of new sources of resistance against Pythium root rot

Rationale: There are relatively very few sources of resistance to Pythium root rot (*Pythium ultimum*). Evaluation of diverse germplasm against the disease may identify new sources of resistance for germplasm improvement or direct use by farmers.

Methods: A total of 650 entries from the IBN-96 nursery (330), Rwandan germplasm (290) collected under the Seed of Hope (SOH) project and advanced elite lines (30) from Rwanda were evaluated in the screenhouse in wooden trays containing soil artificially infected with *Pythium ultimum*. Twelve plants per entry were evaluated in two replications including susceptible (CAL 96) and resistant (RWR 719) check varieties. Entries contained both bush and climbing bean materials.

Results and discussion: *None of the entries evaluated were resistant, but 25 bean materials (3.3%) gave intermediate reaction (Table 7). The remainder were susceptible, indicating the need to evaluate more germplasm. Six entries were selected for inclusion in the Regional Root Rot Nursery.*

Table 7. Reaction of the best entries from IBN and SOH nurseries against Pythium root rot (*Pythium ultimum*) in the screenhouse, Kawanda, 2000.

Entry	Nursery	Reaction[x]
DRK 145	IBN	4.2
MX9065-14B	IBN	4.0
CIFAC 91136	IBN	4.6
LM 93204487	IBN	4.0
ROSADO	IBN	4.3
FIN 5	IBN	5.0
BRB 192	IBN	4.8
IS-49078A	IBN	3.3
DFA 62	IBN	4.3
ICA-GUAYTARA	IBN	4.3
ARS-R-930032	IBN	4.8
L94BO22LE	IBN	4.5
PR93201597	IBN	4.2
BRB 242	IBN	5.2
TB94-01	IBN	5.2
ICTAJU 95-71	IBN	5.5
DICTA 103	IBN	5.3
FOT 68	IBN	5.5
TLP 29	IBN	5.2
187/1	SOH	5.3
315/1	SOH	5.5

[x] = Based on a CIAT scale of 1-9 where 1 is resistant and 9 is susceptible.

Contributor: R. Buruchara

Identification of bush breeding lines with resistance to Pythium root rot

Rationale: The few resistant materials to Pythium root rot consist mainly of small and medium seed types, whereas almost all popular large seeded varieties are susceptible. There is a great need for lines resistant to root rots with a range of preferred seed types to meet the varied demands of producers and consumers.

Methodology: Sixty-eight F_5 lines, derived from F_3 progenies that were resistant to Pythium root rot (*P. ultimum*), were evaluated for resistance against the latter. The progenies, derived from crosses for multiple-resistance involving some of the resistance sources (MLB-49-89A, RWR 719 and RWR 1092) to Pythium root rot, were evaluated as described above.

Results and discussion: Out of the 68 lines evaluated 42 (62%) gave an average reaction of between 1.0 -2.9, 19 (28%) gave a reaction between 3.0-4.9, five (7.4%) were rated between 5.0-6.9, whereas 2 (2.9%) were susceptible. The progenies, most of which maintained popular seed types, will also be evaluated against angular leaf spot to determine those that may have combined resistance against the two pathogens.

Contributors: H. Gridley, R. Buruchara (IP-2); and A. Namayanja (NARO)

Identification of sources of resistance to angular leaf spot (*Phaeoisariopsis griseola*)

Rationale: Three pathogen groups of the angular leaf spot pathogen *P. griseola* (Mesoamerican, Andean and Afro-Andean) have been identified in Africa. This shows the need to identify germplasm, resistant to the pathogen diversity found in Africa, that may be used directly or as sources of resistant to improve susceptible popular varieties.

Table 8. Reactions of some introduced lines to inoculation with a mixture of Andean (3) and Mesoamerican (4) isolates of *P. griseola* under screenhouse conditions, Kawanda, 2000.

		Disease severity[u]	
Entry[v]	Nursery	Andean isolates[x]	Mesoamerican isolates[y]
BRB 229	IBN	3.2	4.8
LM 30630	IBN	3.1	4.5
FM 94003	IBN	1.6	2.3
LM 93204453	IBN	3.0	3.8
AN 9021337	IBN	3.5	3.4
N-905975	IBN	1.2	2.8
Peruano	IBN	2.2	2.0
LM-93203231	IBN	1.1	2.0
DFA-59	IBN	1.0	2.0
DRK-14	IBN	1.0	3.0
AFR 722	ALS	3.7	3.8
MCM 5001 (Check)	Released variety	9.0	9.0
CAL 96 (Check)	Released variety	7.0	8.0
Ex Rico-23 (Check)		4.0	1.0

u = Based on a CIAT scale of 1 (resistant) to 9 (susceptible).

v = Entries: Some of IBN and ALS entries screened.

x = Mixture of 3 Andean isolates each represented in the inoculum at concentration of 2×10^4 conidia per ml.

y = Mixture of 4 Mesoamerican isolates each represented in the inoculum at a concentration of 2×10^4 conidia per ml.

Methods: One hundred and fifty-three entries from the IBN-96 (comprising predominantly lines from CIAT IP-1) and resistant germplasm to certain races in Latin America were inoculated separately with a mixture of selected local Andean and Mesoamerican isolates in the greenhouse. Evaluation was made at weekly interval over three weeks using a CIAT scale of 1 (resistant) to 9 (susceptible).

Results and discussion: Most entries were susceptible to both pathogen groups. A few gave resistant or intermediate reactions with one, while giving a susceptible reaction with the other, and vice-versa. Entries that gave resistant or intermediate reactions to both groups are shown in Table 8. Given the observed mutual occurrence of Mesoamerican, Andean and Afro-Andean pathogen groups in Africa, it is important to search or combine resistance against the three.

Contributors: R. Buruchara and H. Bashieja.

Characterization of resistance against Pythium root rot

Rationale: Few varieties or lines show good levels of resistance against Pythium root rot. The value of resistance in some lines has been demonstrated by the demand and increasing number of farmers growing resistant varieties in western Kenya, Rwanda and southwest Uganda, areas where root rots are severe. These lines are also candidates as parents for genetic improvement of susceptible commercial varieties. Characterizing phenotypic parameters associated with resistance will facilitate identification and selection for resistance against the disease.

Methods: Six resistant / tolerant lines (MLB-49-89A, MLB-40-89A, RWR 221, SCAM-80CM/15, Vuninkingi, AND 1064 and RWR 719), all of which (except AND 1064) are grown in root rot problem areas of Africa, were compared in pasteurized and soil artificially infected with *Pythium ultimum* in the screenhouse. They were assessed one month after inoculation for root and shoot biomass, root length and disease severity using CIAT's' scale of 1-9. CAL 96, a variety released in Uganda as K 132, was used as a susceptible check.

Results and discussion: Reaction (average rating of 8.8) on CAL 96 showed high disease levels. Severity on resistant varieties varied between 3.2 and 5.3 (Figure 3a).

There was no significant reduction in root length on varieties MLB-49-89A, SCAM-80CM/15, 1064 and RWR 719 in infected soils. However, there was modest (20-28%) but significant reduction in root length with other varieties (MLB-40-89A, Vuninkingi, and RWR 221). The highest reduction (64%) was observed on CAL 96 (Figure 3b).

Reduction in shoot and root biomass was observed for all entries grown in infected soil (Figures 3c and 3d). However, reduction in shoot weight was highest (93%) on CAL 96 but varied between 74-80% in tolerant varieties. Similarly, reduction in root weight was highest (91%) on the susceptible variety while reduction in resistant varieties varied between 32% and 64%.

The susceptible check showed strong negative correlation (significant at $p = 0.01$) between disease severity, root length (- 0.98), root weight (-0.99) and shoot weight (- 0.99). On the other hand, no correlation was observed between disease severity and root length among resistant varieties except for MLB-40-89A (-0.89) and Vuninkingi (-0.90). Disease severity correlated negatively with shoot (≥ -0.90%) and root biomass (≥ -0.78%) among all resistant varieties except AND 1064.

It was clear from these and previous results that root length, shoot and root biomass are influenced by disease severity, which in turn depends on the susceptibility of a variety to Pythium root rot. Resistant varieties used gave low but varied levels of disease severity. The latter (which in this case is a measure of infection of the root system) influenced to a greater degree root and shoot biomass, and to a lesser extent root length among resistant varieties. With exception of AND 1064, there was significant ($p=0.05$) positive correlation between root and shoot biomass in all entries studied. This result confirms the negative relationship between roots and shoot biomass with disease severity, and demonstrates the latter to be a major factor associated with resistance or tolerance against Pythium root rots.

Contributors: R. Buruchara and H. Gridley

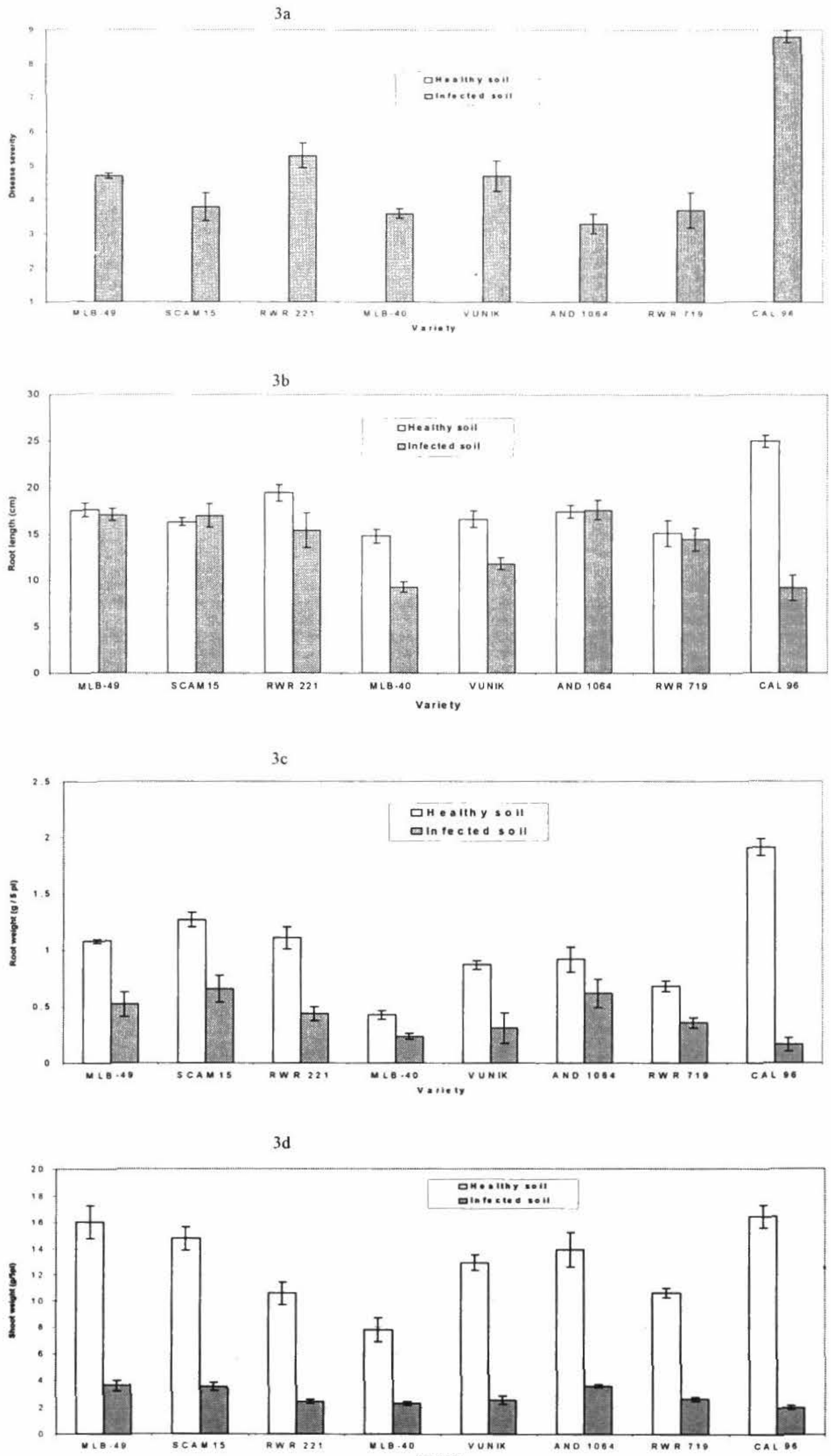


Figure 3. Effects of Pythium root rot on disease severity (a), root length (b), root weight (c) and shoot weight (d) on susceptible (CAL 96) and tolerant bean cultivars. Bars indicate standard errors of means. Screenhouse, Kawanda, Uganda, 2000.

Evaluation of lines for tolerance to stem maggot

***Rationale*:** To solve the formerly intractable bean stem maggot (BSM) problem, additions are needed to the few tolerance varieties now available as part of IPM strategies.

Methods: Germplasm and other lines from the CIAT breeding program need were distributed to several collaborating NARS through the networks for evaluation and potential promotion. Selections were based on tolerance to BSM and yield.

***Results and discussion*:** Results received so far indicated several materials with superior performance against the pest, and some combining this attribute with high yield (Table 9). At both Kisii (western Kenya) and Mulungu (Kivu, DR Congo) the top performers were CIAT bred lines. These two entries are of medium seed size and have purple and cream seed colors, respectively. Other entries, such as the CIAT Genebank lines G 22501 and G 23333 (originally from Burundi) and G 22258 (from Rwanda) and selected through evaluations in Africa of the core collection, showed adaptation and good performance at Mulungu, which is ecologically similar. Some of these materials have shown good performance also in Kenya, Malawi and Tanzania. The TBF lines will now be multiplied and disseminated more widely through IPM promotion activities.

Table 9. Performance of BSM tolerant lines at Mulungu, DR Congo.

Entry	Origin	BSM mortality (%)	Rank		Grain yield (kg/ha)	Rank		Good performance at other locations
GR 13-P	CIAT IP1	15.1 cde	6	(1)[a]	2235.2 a	1	(1)[a]	Kenya, Tanzania
G 22501	Burundi	6.0 e	1	(6)	2102.4 ab	2	(6)	Tanzania, Malawi
GR 13-C	CIAT IP1	13.1 cde	5	(8)	1989.6 abc	3	(7)	Kenya, Tanzania
G 11727	Peru	16.0 bcde	8		1794.4 abcd	4		
G 8047	Kenya	28.7 ab	15	(2)	1739.2 abcd	5	(4)	Kenya, Tanzania
G 22258	Rwanda	17.7 bcde	10		1721.6 abcd	6		South Africa, Tanzania
G 5625	Mexico	16.2 bcde	9	(4)	1568.8 abcde	7	(2)	Kenya, Tanzania
IKI	?	18.3 bcde	11		1499.2 abcde	8		Tanzania
PAD 3	CIAT IP1	7.5 de	2		1335.2 abcdef	9		Malawi
G 23333	Burundi	10.9 cde	4		1086.4 bcdef	10		
ZPv 292	Uganda	19.6 bcd	13		974.4 cdef	11		Zambia, Tanzania
G 11746	Peru	10.1 cde	3		875.2 def	12		Tanzania
G15430	Zambia	18.8 bcde	12		618.0 ef	13		
Beshbesh	CIAT IP1	21.8 abc	14		428.2 ef	14		Ethiopia
G 23070	Malawi	34.9 a	16	(7)	307.4 f	15	(5)	Kenya
G13910	Ecuador	13.5 cde	5		282.4 f	16		

[a] Performance ranking in Kisii, western Kenya

Contributor: K. Ampofo
Collaborators: Mbikayi Nkonko (INERA); J. Ogecha (KARI).

Bean improvement for low fertility soils in Africa (BILFA)

Rationale: Bean is grown in Africa by small scale farmers under low input soil management conditions. Common soil management practice consist of organic manure application at lower than recommended rates. Genetic variation in bean with respect to adaptation to low soil fertility has been already confirmed in two previous cycles of BILFA evaluation.

Methods: The third cycle of evaluation (BILFA III) started in late 1998, and results so far obtained are reported here from the evaluation of 200 entries. Each season, the top 50% of lines are selected and evaluated further for tolerance to a single stress or situation — low N, low available P or low pH. Fifty promising lines identified to be tolerant to at least two stresses at a BILFA collaborators meeting held in 1999 were further evaluated in multilocation testing in 2000 at all sites. This is an example of a strategic activity initiated by CIAT and now run entirely by network scientists.

Results and discussion: Several lines gave outstanding performing across sites and stresses. Tolerance to all three stresses were reconfirmed in the following lines: VEF(88)40LPYT6, CIM 9314-1, LSA 32 and PAN 150. These are therefore proposed as parents for breeding programs to develop materials with multiple constraints tolerance. The CIAT bred lines FEB 197, ARA 4, DAF 53 have shown tolerance to low P and low pH, while AFR 706, AFR 714 and CIM 9414-34 have shown tolerance to both low N and P.

So far, 14 promising BILFA III lines are being used as parents in the ECABREN breeding program for multiple constraints resistance development at the University of Nairobi by P. Kimani. In the latter program, six University-bred lines performed better than checks from the BILFA set (BAT85 and UBR(92)12(P)) in low P vs applied P conditions. A small number of lines tolerant to low N conditions were also selected at the University's Kabete farm from crosses made there. These preliminary results indicate that variation for tolerance to low soil N exists in this breeding program. Many other materials with specific soil tolerances are needed to develop the various market bean types in different national bean programs (see 2.1 above).

Materials with marketable characteristics are being tested in on-farm trials with farmers in Western Kenya, Eastern Congo and in Malawi. At least two lines are expected to be adopted by farmers by the end of the next year at each site.

Contributors: Lunze Lubanga (INERA); P. Kimani (IP2/University of Nairobi).
Collaborators: Scientists in ECABREN and SABRN.

Activity 2.3 Cost effective innovative methods for variety development

Achievements:

- In the second year of a formal comparison of participatory and conventional breeding in two countries, both formal breeders and farmer-selectors suffered some setbacks due to logistical or environmental difficulties.

- In Ethiopia, farmers selections were clearly influenced by characteristics of local varieties, yet selected enthusiastically some unknown seed types, suggesting that their narrow genetic base for this crop is related more to access to new germplasm than to fixed preferences.

- Selection criteria used by a male-dominated group and by women were significantly different, while men's resource level had little effect.

Participatory plant breeding

Rationale: Bean production in Africa ranges from high-potential to low-potential or marginal areas. The low potential areas, constituting a myriad of micro-environments, require breeding approaches distinct from the traditional multi-site trials on research stations and which take account of the inadequate support to research by most countries. More decentralized approaches should exploit, rather than avoid, genotype by environment interaction, making use of specific adaptation and the participation and indigenous knowledge of farmers. On-farm trials of advanced breeding lines go part way towards this, but customarily comprise limited and elite genetic diversity and are often conducted to obtain yield data rather than to provide a selection 'pool' for farmers to exploit. This project aims to formally evaluate participatory plant breeding.

Methods: Our collaborators in this 3-year project started in late 1998 are three institutions in Ethiopia (ARC in the southern Rift Valley, EARO at Nazreth in the central Rift Valley and Alemaya University in the Hararghe Highlands) and one in northern Tanzania (DRD Selian). Ethiopia has the distinction of being one of the very few countries that funds its research well; it is also, however, a country with an unusually low level of bean genetic diversity on farm, due to later introduction of the crop and to the release of few varieties before the 1990s.

<u>Ethiopia</u>: In the first year breeders and small farmers (farmer-selectors) evaluated and then selected lines in a diverse germplasm pool on-station. In the following two years the breeders follow a 'classical' breeding approach, whilst the farmers evaluate their selected lines on their own farms. In the third year the breeders' and farmers' final selections are evaluated by other small farmers (farmer-evaluators) and by the breeder in multi-location trials. Accounts are kept to compare the cost effectiveness of classical and PPB methodologies in developing lines that are readily adopted by small farmers. Farmer-selectors (FS) and breeders are currently making their final selections for sowing on-farm and in multi-site yield trials, respectively, in 2001.

<u>Tanzania</u>: Selection was planned to follow the same pattern as in Ethiopia but initiated in populations segregating for resistance to bean stem maggot (BSM) and angular leaf spot (ALS), locally (and regionally) important biotic constraints. In 1999 the BSM-selected populations suffered a severe attack of powdery mildew that prevented the selection of single plants by FS and the breeder, and the program was re-initiated in 2000 with the first set of single plant progenies (from three populations) currently being evaluated on-farm and a further four populations for BSM. Selection in the ALS populations initiated in 2000 identified 175 single plant progenies for evaluation in 2001.

Results and discussion:

Ethiopia - Nazreth

Male farmer-selectors at the two villages of Bofa and Wolenchtiti have selected on-farm since they initiated selection on-station in the germplasm pool of 273 lines in 1998. In 1999 male FS at Bofa sowed a total 267 selections, comprising 63 lines from the pool, with from 5 to 30 selections per farmer. Wolenchiti male FS sowed 295 selections, comprising 42 lines, ranging from 12 to 24 per farmer. At Bofa, male FS dramatically reduced their number of lines for sowing in 2000, with only 76 retained (3 to 9 per FS) representing a mean decrease of 42% per farmer. Female farmer-selectors sowed 6 to 9 selections, comprising 28 lines from the pool, on farms in 2000 following selection on-station in 1999 (Table 10).

Table 10. Number of lines selected by farmer-selectors in two Nazreth villages from a germplasm pool of 273 bush lines.

Male farmers in Bofa				Male farmers in Wolenchiti		Female across villages	
Farmer-selector	Number of lines		% selected in 1999	Farmer-selector	No. of lines sown 1999	Farmer-selector	No. of lines sown 2000
	Sown 1999	Selected and sown 2000					
Shumi	30	ND	-	Aberra	24	Dansa	8
Gudata	22	7	31.8	Negashu Bunne	24	Derra	6
Bekele	21	5	23.8	Ararso Bedada	21	Belula	8
Zekarias	21	9	42.9	Gemechu Kumbi	21	Ruffo	9
Gemechu	17	5	29.4	Degaga	19	Afrasa	6
Deme	16	4	25.0	Taddesse	17	Tsige	5
Girma	16	8	50.0	Teshome	16	Shewa ye	5
Kurfa	16	8	50.0	Tolla	15	Jomba	5
Belda	14	ND[1]	-	Kinfe	15	Dinke	7
Roba	14	ND	-	Kiltu	15	Dinknesh	6
Dori	12	4	33.3	Bogale Demissie	15		
Feyisa	10	4	40.0	Fentale Birra	15		
Kumbi	10	ND	-	Deme Balcha	14		
Reta	8	3	37.5	Tesfaye	13		
Bedasso	7	5	71.4	Shumi Geda	13		
Beyene	7	4	57.1	Beshada Gurma	13		
Jufaru	7	3	42.9	Bune Tura	13		
Melketo	7	3	42.9	Amare	12		
Mulu	7	4	57.1				
Boru	5	ND	-				
Total	267	76			16.4		6.5
Mean	13.4	5.1	42.3		295		65

Note: male farmers at Bofa and Wolenchiti selected on-station in 1998 and sowed in 1999 and 2000; female farmers from both villages selected in 1999 and sowed in 2000.

No more than 12% of the 93 lines were common to those sown in 1999 by the male FS at the two villages and selected by female FS across villages for sowing in 2000. This suggests marked preference differences, although the three groups did evince a similar preference for small to medium red and white seeded lines (Table 11). This likely reflects the seed color and size of the two most widely cultivated and popular local varieties, Red Wolaita (red) and Mexican 142 (white pea bean), grown for food and cash, respectively.

An open-ended questionnaire elicited differences in selection criteria applied by male and female FS, but little between the two groups of male selectors for whom the most important selection criteria were yield followed by earliness, tolerance to drought, seed color and potential to sell in the local market. Yield was also the most important for female farmers but by contrast their second criterion was the 'conceived' quality of a line for preparing the local bean dish 'nifro' and potential to sell in the local market and to traders for export. Data needed to fully understand the variation in the lines selected by the three groups and the expected role of specific adaptation will be examined by multi-location on-station and on-farm yield trials planned for next year.

Table 11. Composition (% by seed color/type and size) of lines selected once (1), and more than once (>1), by male farmers in 1999 and female farmers in 2000, in two Nazreth villages.

Seed colour or type	Male (Bofa)		Male (Wolenchiti)		Female (both sites)		Seed size[1]	Male (Bofa)		Male (Wolenchiti)		Female (both villages)	
	1	>1	1	>1	1	>1		1	>1	1	>1	1	>1
Red	62.2	70.1	60.0	67.8	46.4	42.9	Large	7.5	9.4	5.8	15.3	7.1	0.0
White	17.2	12.6	20.7	13.6	17.9	14.3	Medium	75.7	78.7	73.2	6.8	75.0	85.7
Carioca	6.4	4.7	6.8	3.4	14.3	7.1	Small	16.9	11.8	21.0	78.0	17.9	14.3
Cream	5.2	4.7	4.7	5.1	10.7	21.4							
Calima	4.5	3.9	3.4	5.1	3.6	14.3							
Yellow	3.0	2.4	1.7	0.0	0	0.0							
Brown	1.5	1.6	1.4	1.7	3.6	0.0							
Sugar	0.0	0.0	1.0	3.4	3.6	0.0							
Pink	0.0	0.0	0.3	0.0	0.0	0.0							

[1]. 100 seed weight for large, medium and small: ≤40g, 20-39g and ≥ 19.

Ethiopia - Awassa

In the second season of 2000, 17 male and female farmer-selectors (FS) at the village of Remada and 15 at the village of Korongogie evaluated on-farm 170 and 234 selections, respectively. These lines stemmed from selection in a germplasm pool of 127 lines grown on-station in the first season of 1999. The pool comprised 26 large seeded and 94 medium or small seeded lines (with 7 as yet unclassified for seed size), all with bush growth habits aside from 6 climbers.

At Remada the selections sown consisted of 98 large seeded and 72 small to medium lines with the FS evaluating a mean of 10 lines, comprising 6 large and 4 small/medium. At Korongogie they consisted of 122 large and 112 small/medium lines with the FS evaluating a mean of 16 lines equally divided between seed size classes. In both villages large seeded lines dominate farmers' provisional selections for next season, even though few, if any, have grown such types before — their previous experience being limited to the same small to medium seeded local cultivars Red Wolaita and Mexican 142. Farmers at Remada are particularly enthusiastic, stating that large seeded lines "taste like meat without the blood".

The FS at Korongogie sowed a greater proportion of lines from the original pool than their counterparts in Remada (Table 12). The provisional selection of all large seeded lines at both villages, compared to 68 to 71% for the smaller sizes, reinforces the trend, noted above, in farmers' preference for large seeded lines.

The most important criteria mentioned by farmers in their selection of lines from the germplasm pool in 1999 were growth habit, plant height, pod load, pod length, pod height, early maturity, seed color and size. Selection criteria for lines within the seed size classes is being elicited to further refine characteristics of importance to FS and hence to improve the breeder's efficiency.

Table 12. The number of large and small/medium lines selected in 2000 and provisionally[1] selected for sowing in 2001 by farmers in two villages near Awassa.

Parameter	Farmer selectors in village of:			
	Remada	Korongogie	Remada	Korongogie
	large-seeded		small/medium seeded	
Number of lines sown	26	30	38	69
Number of lines provisionally selected[1]	26	30	26	49
Percent provisionally selected	100.0	100.0	68.4	71.0
Range in selection frequency of individual lines	1 to 8	1 to 11	1 to 4	1 to 5
Mean frequency of selected lines	3.3	3.9	1.3	1.6

Note: [1] Lines that the farmer indicated that s/he would likely select for re-evaluation next season.

Ethiopia – Alemaya

In contrast to the other locations in Ethiopia, the initial selection phases were conducted communally by farmer-selectors in three user-groups, comprising six resource-poor farmers (RPF), six resource-rich farmers (RRF) and 10 women farmers (WF), which is their normal practice in assessing 'new technologies'. Communal selection on-station in 1998 by farmer-selectors in the RPF, RRF and WF user groups selected 41, 36 and 52 lines (Table 13), respectively, from a germplasm pool comprising two nurseries of 25 climbers and 239 bush lines. From these nurseries the breeder selected 24 bush lines and 8 climbers to enter the conventional breeding program.

In 1999 the farmer-selectors (FS) in each user-group communally evaluated their selected lines on one farmer's field in the group. As crop growth in first season was poor due to drought, the FS re-evaluated all lines in the second season and the RPF group individually selected 40 lines (from 19 to 27 lines per FS) for evaluation on their own farms in 2000. The RPF and WF groups communally selected 12 and 13 lines, respectively, for communal evaluation (Table 13).

In the season 2000a, the six RPF selected a mean of 13 lines (ranging from 8 to 16 per FS), and rejected from 8 to 15 lines amongst their individual selections sown on their own farms. The RPF and WF sowed fewer lines than the RPF, but proportionally selected more and rejected fewer, both selecting a mean of 9 lines (ranging from 5 to 10 lines for RPF to 6 to 13 lines for the WF) (Table 14).

In the second season of 1999 the frequency of bush and climbing lines selected by the three user-groups was similar. By the second season of 2000, however, the RPF had selected more than twice as many bush lines compared to the other groups (Table 13).

The 32 lines in the conventional breeding program were evaluated in multi-location replicated yield trials in 1999 and 2000 following the normal selection procedure.

Selection criteria across user-groups emphasised yield and yield components (pods/plant, seeds/pod, seed size), with drought resistance making the next criterion; within the user-groups, at least 83% of farmer selectors rated these criteria in the top five (Table 15). Cooking quality, market value and cooking time ranked only 10th, 14th and 24th, respectively, when averaged across user-groups, reflecting their relative lack of importance to both male-dominated groups and potentially over-riding their clear importance to women farmer-selectors. Some criteria usually of importance to breeders were not valued by farmers.

Table 13. Number and growth habit of lines sown for evaluation by farmer-selectors in each user group and by breeder at Alemaya, from 1999a to 2000a.

Year / Season[1]	User Group with number of farmers, evaluation type[2/3] and number of lines sown						Breeder
	Resource-poor		Resource-rich		Women		
	Communal	Individual[3]	Communal	Individual	Communal	Individual	
1999a	41	None	36	None	52	None	32
1099b	41	None	36	None	52	None	32
2000a	None	40	12	None	13	None	32

Frequency of bush and climbing lines	1999b				2000b			
	Poor	Rich	Women	Breeder	Poor	Rich	Women	Breeder
Bush	37	33	44	24	29	9	11	24
Climbing	4	3	8	8	4	1	2	8

1. Season 'a' and 'b' represent the first-short and second-long rainy season in a year, respectively.
2. Communal evaluation is undertaken on one of the groups' farms by all farmers in the User-Group.
3. Individual evaluation is a farmer evaluating lines selected by him.

Table 14. Number of lines sown, selected and rejected in season 2000a by farmer-selectors in three user groups in Alemaya area.

Resource-poor				Resource-rich				Women			
Farmer	Sown	Select	Reject	Farmer	Sown	Select	Reject	Farmer	Sown	Select	Reject
Mohomed	21	8	13	Mahadi	12 sown communally	10	2	Rumia	13 sown communally	9	4
Abrahim	24	16	8	Hasan		10	2	Annisa		10	3
Jemal	27	12	15	Tili		10	2	Rumia		9	4
Elias	26	13	13	Adam		10	2	Mardia		9	4
Idris	19	13	6	Aliy		10	2	Deneba		10	3
Ibsa	27	15	12	Usman		5	7	Rumia		13	0
								Mako		6	6
								Kimia		7	6
								Hindia		9	4
								Fatuma		8	4
Total	144	77	67			55	17			90	38
Mean	24	13	11			9	3			9	4

1. RRR, RPF, WF: Resource poor, resource rich and women farmers, respectively.

Table 15. Frequency (%) of selection criteria by farmer-selectors in three Alemaya user groups.

Rank	Selection Criteria	Resource-poor (6)	Resource-rich (6)	Women (10)	All farmer-selectors
1	Pods/plant	100	100	100	100
2	Drought resistance	100	100	100	100
3	Yield	100	83	100	95
4	Seeds/pod	100	100	80	91
5	Seed size	83	83	90	86
6	Seed colour	67	100	70	77
7	Plant height	50	17	100	77
8	Pod length	83	0	100	68
9	Forage yield	17	50	90	59
10	Cooking quality	17	50	70	50
11	Growth habit	50	17	70	50
12	Pod filling	100	50	20	50
13	Stalk strength	50	67	40	50
14	Market value	17	17	80	45
15	Seed shape	0	50	50	36
16	Seed plumpness	67	17	30	36
17	Synchrony of maturity	83	17	10	32
18	Disease resistance	67	17	10	27
19	Insect resistance	67	17	10	27
20	Pod appearance	50	0	20	23
21	Stand uniformity	83	0	0	23
22	Green leaf persistence	17	50	40	36
23	Multiple harvesting	17	0	50	27
24	Cooking time	0	0	40	18
25	Suitability for local stew	17	33	0	14
26	Shattering	50	0	0	14
27	Seed weight	17	17	0	9
28	Earliness	33	0	0	9
29	Boiled grain volume	0	0	20	9
30	Lodging	33	0	0	9
31	Green pod consumption	17	0	10	9
32	Germination	33	0	0	9
33	Days to podding	33	0	0	9
34	Leafiness	0	0	20	9
35	Height basal pod from soil	17	0	0	5
36	Leaf shedding	17	0	0	5
37	Storage life	0	0	10	5
38	Rejuvenation capacity***	17	0	0	5
39	Termite resistance	17	0	0	5
40	Vigour	0	0	10	5

Tanzania

In contrast to locations in Ethiopia, the protocol in Tanzania envisaged farmer-selectors and the breeder developing lines for on-farm evaluation from selection in segregating populations. Accordingly, single plant selection was initiated in 1999 in populations segregating for resistance to bean stem maggot (*Ophymia* spp.) and angular leaf spot (*Phaeoisariopsis griseola*), locally important biotic constraints.

Three F^5 BSM populations: The BSM-resistant parent of each of these three populations (resown from remnant seed after loss of last year's evaluations) was ZPv292; the other parents were the locally released cultivars Dore de Kirundo, Lyamungu 85-2 and Canadian Wonder. Four farmer-selectors and the breeder sowed the populations under irrigation in November 1999 for screening against BSM (Table 16). At the station site used by the breeder, severe drought resulting from insufficient irrigation, prevented selection of single plants. The farmers, however, made 82 F^5 single plant selections (SPS) in the three populations, with the derived F^6 single plant progenies (SPP) multiplied on-station during the long rains (April-July) in 2000 (Table 16). 82 F^7 SPP were sown on the fields of four farmer-selectors in August 2000 and are currently being screened against BSM and for all farmer-selectors project to select SPP to evaluate on their own fields in ensuing seasons.

Table 16. Progress in selecting for resistance to BSM in three segregating populations.

Sowing date	Action[1]	
November 1999	Three F^5 populations screened for resistance under irrigation	
	↓	
	82 F^5 SPS made	
	↓	
April 2000	82 F^6 SPP multiplied on-station	
	↓	
August 2000	82 F^7 SPP sown on four farmers' fields	
	↓	
		Plot size
	Liberatus Silvano 26 F^8 SPP	1 row of 3m
	Elizabeth Anthony 10 F^8 SPP	2 rows of 3m
	Mathew Shekibula 18 SPP	2 rows x 3m
	Hapines Shekibula 28 SPP	2 rows x 3m

Note: SPS and SPP: single plant selection and single plant progeny, respectively.

Four F^5 BSM populations: The parents of these populations are G3844 x ZPv 292, ZPv 292 x EMP 81, G3844 x G2005 and ZPv292 x Lyamungu 85-1. Seed of the populations was increased under irrigation at Madira in late 1999. The F^6 populations were sown on 11 farmers' fields in August 2000 and are currently being evaluated for resistance to BSM by both farmer-selectors and the breeder, who will make single plant selections at physiological maturity.

Angular leaf spot (ALS): Nine F^4 ALS populations segregating for resistance to ALS were multiplied in 1999 with F^5 seed sown by 20 farmer-selectors in April 2000. However, only four farmers managed to produce a good crop in which all farmer-selectors were invited to select F^5 single plants most appealing to each of them. These farmers made a total of 177 single plant selections, the majority coming from the following 5 populations: LB2878 x LB842-1 (27 SPS), UBR(92)25 x LB 2465 (28 SPS), LB2878 x LB2465 (26 SPS), LB2465 x ZAA84044 (28 SPS) and A409 x LB2878 (22 SPS). F^6 seeds of each SPS are being multiplied under irrigation for sowing in farmers' fields in March/April 2001.

Yield and seed color accounted for 28% and 27% of the criteria used by the FS in selecting single plants, followed by pod load, disease resistance, drought and seed size ranging from 5% to 9%; the other 10 criteria accounted for less than 4% each. Cream seed was by far the most popular color (30% of selections) followed by pink-Flor de Mayo at 15%, red kidney at 13%, brown-maroon at 12% and dark red kidney at 8%. Small and medium seeded materials accounted for 82% of the selections (Table 17).

Table 17. Selection criteria (%) applied by Tanzanian farmer-selectors in selecting 175 single plants.

Selection criterion[1]	%	Seed colour/type	%	100 seed weight classes	%
Yield (+)	28.1	Cream–mulatinho	30.3	≥50	1.7
Seed colour	27.3	Pink-flor de Mayo	15.4	40-49	6.9
Pod load (+)	9.1	Red kidney	12.6	30-39	25.7
Disease resistance (+)	6.7	Brown-maroon	12.0	20-29	56.0
Drought (+)	4.7	Dark red kidney	8.0	≤19	9.7
Seed size (+)	4.7	Cream-pinto	5.7		
Seeds/pod (+)	3.7	Red-zamarano	2.9		
Seed shape	3.4	Black	2.3		
Plant vigour (+)	2.5	Purple-mortino	2.3		
Plant architecture	2.2	Red-calima	1.7		
Seed quality	2.2	Red-duva	1.7		
Branches (+)	2.0	Red-pompadour	1.7		
Climb swell	2.0	Pink	0.6		
Cooks well	0.5	Red–calima	0.6		
Early maturity	0.5	Red–duva	0.6		
Adapted well	0.2	Red–zamorano	0.6		
Bush type	0.2	Red	0.6		
		Red-cafetero	0.6		

[1]. (+) indicates that higher values preferred by farmer-selectors.

Contributor: H. Gridley.
Collaborators: Farmer-selectors in study villages in Ethiopia and Tanzania; Habtu Assefa and breeders, pathologists, economist in Ethiopia (EARO, ARC, Alemaya); F. Ngulu and colleagues in Tanzania (DRD); L. Sperling (CIAT/PRGA); R. Kirkby.

Activity 2.4 Distribution of improved germplasm to network participants

Achievements:

- Segregating populations from crosses, and parental materials for various market classes, were distributed to breeders in 8 countries by a decentralised regional breeding program established through a new collaborative agreement with the University of Nairobi.

- Germplasm with useful traits (resistance to root rots, anthracnose and angular leaf spot) were distributed to NARS breeding programs in six countries.

- Regional exchange of elite materials among countries and from CIAT breeding programs in Africa and at Headquarters enabled several Southern African countries to identify potential new varieties, including some of interest to the commercial sector.

Network collaborators receive germplasm resources

Rationale: NARS breeding programs, aspiring to greater effectiveness and self-sufficiency in cultivar development while facing personnel and other resource limitations, need access to new materials with traits that address African priorities. CIAT bridges this gap by providing advanced lines, segregating populations, source parents and on-site support during the planning, implementation, monitoring and evaluation of bean improvement activities.

Materials and methods: Seed of genetic resources, received from CIAT IP-1 in Cali (Colombia), from CIAT IP-2 at Kawanda (Uganda) or generated from a new University of Nairobi/CIAT regional breeding program at Kabete (Kenya) was increased during the 1999B and 2000A seasons. Requests were invited from collaborating breeders and others in Africa.

Results and discussion: A total of 224 segregating populations from multi-parent crosses were distributed to 10 countries in 1999B season. Each national program received and planted at least 15 populations for the 2000A season, and in the 2000B season 1,385 entries were sent to five NARS in ECABREN countries. These materials included advanced lines and F_4/F_5 progenies selected from multiple constraint nurseries (Table 18).

Table 18. Distribution to African NARS of regional breeding materials in 2000.

Country	2000A		2000B	
	No	Type	No	Type
Burundi	15	Segregating populations	-	-
Congo DR	45	Segregating populations	181	Sugarș, yellows, brown and tans
Ethiopia	30	Segregating populations	201	Small red, navy, carioca
Sudan	15	Segregating populations	-	-
Madagascar	-	Segregating populations	19	Large white
Tanzania	30	Segregating populations	294	Large dark red kidneys
Rwanda	15	Segregating populations	-	-
Uganda	44	Segregating populations	660	Red mottled and dark red kidneys
Zambia	15	Segregating populations	-	-
South Africa	15	Segregating populations	-	-
Kenya	-	-	30	Pintos
Total	224		1,385	

NARS partners are evaluating these materials under important stresses and local growing conditions. Each leading NARS is also expected to share improved materials with other NARS that may be interested in a particular seed type. It is expected that promising lines will be tested with farmers and other partners, and NARS will release and maintain breeders' seeds.

Contributor: P.M. Kimani (IP2 and University of Nairobi)

Multiplication and distribution of selected disease nurseries

Rationale: Sources of resistance against important bean diseases have potential for being used directly, or as parents to improve popular but susceptible commercial varieties.

Methods: Selected nurseries and germplasm were multiplied and distributed according to requests from network partners.

Table 19. Disease resistance germplasm distributed to NARS in Africa.

Nursery / Germplasm	No. of entries	Destination
Root Rot Regional Nursery	67	Kenya, South Africa, Uganda
Root rot resistant lines	10	Kenya, South Africa, Uganda
Angular leaf spot resistant lines	36	Kenya
Anthracnose resistant lines (white seeded)	8	Zimbabwe
ALS differentials	12	Kenya, Rwanda
Anthracnose differentials	12	Ethiopia, Rwanda.
Fusarium wilt resistant / susceptible lines	8	Uganda

Results and discussion: A total of 135 entries consisting of lines resistant to Pythium root rot, and angular leaf spot and anthracnose were distributed to partners as shown on Table 19. Also distributed were differentials for *P. griseola*, *Colletotrichum lindemuthianum*, and lines for specific studies on *Pythium* and *Fusarium* spp.

Contributor: R. Buruchara
Collaborators: Scientists in ECABREN and SABRN countries.

Southern Africa regional trial and nursery

Rationale: Malawi has been co-ordinating regional bean trials since the early 1990's, most recently under the Southern Africa Bean Research Network (SABRN) with some support from CIAT-PABRA. The main objective is to share germplasm within the network so that each national program or private sector collaborator can benefit from research carried out by others in the region. The main beneficiaries are the weaker national programs that are not able to run a full-scale breeding program, although even the stronger programs that contribute most materials gain from the opportunity to monitor occurrence of new and existing diseases and insect pests.

Methods: Two types of trials are distributed to SABRN member countries: the Southern Africa Regional Bean Evaluation Nursery (SARBEN) containing improved germplasm generated by various national bean-breeding programs in the region, and the Southern Africa Regional Bean Yield Trial (SARBYT) of outstanding or released bean cultivars from the region.

The SARBEN nursery consisted of 100 entries including one local check from each participating country. Most entries were contributed by Malawi, and these were from two separate sources; a) introductions through CIAT and b) those from the CIAT-Malawi breeding program (coded CIM). In total 12 sets were distributed to 7 countries: Mozambique (1), Zambia (2), South Africa (2), Swaziland (1), Tanzania (1), Zimbabwe (2) and Malawi (3). The design was unreplicated single row plot, 4 m long. Entries are at an early stage, some are still segregating, to offer national breeding programs diverse materials. This recognizes the fact that some national programs may not have the capacity to generate their own segregating populations. Observations were made on general plant growth, diseases and grain yield.

The SARBYT trial consisted of 20 entries contributed by countries in the region. Each country was required to add in one local control variety. The experimental design was a randomised complete block with 4 replications, and plots were of 4 rows measuring 4 m in length. The trials were distributed to 5 countries in the region: Mozambique (1), Zambia (2), South Africa (2), Swaziland (1), Tanzania (1), Zimbabwe (2) and Malawi (4).

Results and discussion: At the time of this write up, data for SARBEN was available from two locations each in Malawi and South Africa, and one location each in Zambia and Swaziland. Angular leaf spot (ALS) was most severe at Bembeke with scores ranging from 1-8; several lines showed good levels of resistance with scores between 1-3, both from local crosses in Malawi and ones obtained from CIAT HQ (IP-1), and including both large and small seeded materials in Andean and Mesoamerican gene pools. Most of the CIM lines are large seeded calima type, a market type that is gaining popularity in Malawi and Zambia and parts of Angola. Common bacterial blight (CBB) was most severe at Chitedze and Bembeke (Malawi) with scores up to 8, but only two lines showed consistently good scores, both being from local crosses made in Malawi. Generally yields were reasonably good in most sites except Malkerns in Swaziland, with some lines above 2000 kg ha^{-1} at various sites. Several small and large seeded cultivars have been selected based on their disease reaction and yield performance for observation in subsequent nurseries and trials.

In the SARBYT, several sites had problems of virus or flooding, and were abandoned. Incidence of ALS was severe at Bembeke, Nchena-chena and Bvumbwe, and a few cultivars (DOR 764, BRB 45, UBR (92) 25, SUG 131, and G3010) showed resistant to moderate reaction. It is interesting to note that lines like UBR (92) 25 from the CIAT Uganda breeding program are proving their potential under more than one constraint — this line is good under low N, low P, low pH complex and also under ALS pressure. Common bacterial blight (CBB) was observed at several sites, but materials with resistance are lacking; breeding work is underway to introduce more genes for resistance to CBB from VAX lines obtained from CIAT HQ (IP-1).

Other diseases that were reported on one or more sites were bean common mosaic virus (BCMV), rust, floury leaf spot (FLS), halo blight (HB), and ascochyta (ASC). A few cultivars showed some resistance to accochyta: FOT 29, POA 8, MCD 2410, C 30-P21 and SUG 131. SUG 131 is one of the sugar bean varieties that have been performing well in the regional trials and is going into on-farm testing in Malawi. Malawi is in desperate need for a sugar bean variety that can be recommended for production to capture the regional sugar bean market in Zimbabwe and South Africa. Zimbabwe is also looking at SUG 131 as a potential variety.

Yield analyses indicate variety x location interactions were very highly significant ($P<0.001$); different varieties may be recommended for different sites. The individual location analyses showed that, at all sites except Greytown and Nchena-chena, differences among varieties were highly significant (Table 20). The mean location yields ranged from poor (below 1000 kg ha^{-1} at three sites in Malawi) to good (over 1500 kg $ha^{-1)}$ at two sites in South Africa (Greytown, Delmas) and Bembeke in Malawi. Some cultivars selected were DOR 764, POA 8, C30-P21, and UBR (92) 25, that seemed to have expressed their potential fairly well even under severe stress conditions. UBR (92) 25 is a small white cultivar that might be suitable for the canning industry, but needs investigation of its canning qualities for the regional market in South Africa and Zimbabwe.

During the few years that these trials have been in circulation, some countries have already benefited. Zambia and Malawi have released more than one variety in common that were introduced through such networking. Angola has identified some varieties and has received seed for multiplication from the network. South Africa is producing seed of some of these varieties, like CAL 143 and A197 through the private seed company PANNAR, targeting the Malawi market. Both these varieties are also in Zambia, and some farmers in Angola have approved them. Lines like CAL 143, AND 277 and AND 279 have shown some resistance to ALS in the past and are now being used as sources of resistance in breeding programs to pyramid genes in new cultivars.

Table 20. Performance of some lines and cultivars included in Southern Africa Bean Yield Trial (SARBYT), 1999-2000.

		Seed Yield in kg/ha								
No	Variety	GTWN	DLM	BBK	CTZ	BVU	SW	ZA	NTN	Mean
1	FOT 29	1498	1670	1940	186	940	488	863	712	1037
2	DOR 764	1275	2434	1413	426	1492	1565	1559	972	1392
3	POA 8	1620	1671	2224	587	1180	1601	1355	920	1395
4	MCD 2410	1806	1483	1836	512	982	823	857	851	1144
5	G 14675	1002	2092	1006	136	547	1351	1068	417	952
6	PEMBELA	1502	1652	1495	156	656	430	658	469	877
7	C 30-P21	1539	1845	2382	634	1497	1356	995	816	1383
8	BRB-45	1528	1631	1907	543	802	1556	992	1076	1254
9	OPS-RS2	1644	2401	863	38	594	1458	1541	781	1165
10	UBR(92)25	1954	3595	1728	972	1122	1432	1091	764	1582
11	ZAA 5/2	2310	1987	1563	475	956	971	1144	521	1241
12	RAB 482	1787	1717	1340	275	542	1341	2104	1007	1264
13	SUG 131	1845	1635	2091	416	1008	510	981	799	1161
14	AND 871	1565	1314	2227	501	1211	1016	1178	816	229
15	BOLON BAYO	1120	641	1210	377	487	707	520	521	698
16	G 9899	1319	2393	1980	206	354	1036	1240	816	1168
17	AFR 553	1201	1259	1598	212	839	783	823	694	926
18	G 3010	1623	1505	1044	256	417	1029	1616	677	1021
19	CORNEL 49242	1470	573	475	115	1154	1011	1834	694	916
20	LOCAL	1822	4196	827	890	266	1642	1534	799	1497
	Mean	1572	1885	1557	396	852	1105	1198	756	1165
	CV (%)	30	39	22	78	22	49	24	39	41
	SE + Loc									49.2
	Variety	236	369	171	154	92	268	141	171	78
	L x V									220
	Signif									**
	Var	ns	**	**	**	**	**	**	ns	**
	L x V									**

Note: CTZ = Chitedze, BBK = Bembeke, BVU = Bvumbwe, NTN = Nchena-chena (Malawi); ZA – Misamfu (Zambia); SW = Malkerns (Swaziland); DLM = Delmas (South Africa);GTWN = Greytown (South Africa)

Contributors: Rowland Chirwa (SABRN)
Collaborators: National programs of the SABRN region; SACCAR; CIAT IP-1 and IP-2.

Unsurprisingly, simple technologies requiring little labor and inexpensive, locally available resources were ranked as the best options were ranked as the best options. Technologies that required purchase of inputs or were labor intensive were rated as average. Long-term trials with no immediate benefits, like improved fallow and agroforestry, were ranked low, albeit tentatively at this early stage in the project. However, farmers expressed interest in the trials, wished to participate in further design and execution, and identified training needs.

Table 25. Technology assessment priority matrix by farmers in Imanyiro (Iganga, Uganda)[1].

Technology	Class I				Class II				Class III			
	Sustain ability	Cost	Time	R	Sustain ability	Cost	Time	R	Sustain ability	Cost	Time	R
FYM	++	+++	+++	4	++	++	++	2	-	-	-	-
Deep tillage	+++	+++	+++	1	+++	++	++	1	-	-	-	-
Minjingu rock P	++	+	++	8	++	+++	+	6	+	++	+++	3
Greenmanure	+++	+++	+	5	++	+++	+	4	+++	+++	++	1
Mulching	+++	+++	+++	3	++	++	+	4	+++	+	++	3
Trenches	+++	+	+++	6	+++	+	+++	6	++	+	+++	6
Improved fallow	++	++	+++	10	++	+	+	11	++	+	+	8
Compost	+++	+++	+++	2	+++	++	++	8	+++	++	+	2
Agroforestry	+++	+	+	11	+++	+	+	9	+	+	+	9
Busumbu rockP	++	+	+++	8	+++	+	+++	2	+	++	+++	5
Soil fertility test strips	+++	+	+++	6	++	+	+++	10	+	+	++	7

Key: + least good; ++ = good; +++ best

[1] Some technology assessment criteria and scores used to rank innovations are not included in this table

Contributor: A. Esilaba (CIAT-PE2/IP2)
Collaborators: J. B. Byalebeka (NARO-KARI); Nakiganda and S. Mubiru (NARO-NAARI); M. Mbalule (NARO-FORI); D.Ssenyange (Africa 2000 Network/UNDP); R. Delve (CIAT/TSBF); AHI; C. Palm (TSBF); IFDC, J. Ojiem (KARI); P. Ndakidemi (DRD).

Activity 3.2 Development of IPM components

Achievements:

- Root rot identified as attaining serious pest status in Trans-Nzoia district of western Kenya, with high farmer demand for resistant varieties identified elsewhere.

- Eight species of *Pythium* spp identified as prevalent in areas of Uganda seriously affected by root rots; *Fusarium oxysporum* f.sp *phaseoli* predominanted.

- Changes in bean stem maggot (BSM) population composition were highlighted. Preliminary results indicated that tomato and cowpea attract BSM into bean intercrops.

- Presence of bean stem maggot and nematodes increased incidence and severity of Fusarium wilt, implying that integrated management will be needed.

Participatory evaluation of root rot management in Trans-Nzoia district, Kenya

Rationale: Some areas (Meso and Nakwangwa) in the formerly large-scale maize and wheat growing district of Trans-Nzoia in Kenya's Rift Valley province are experiencing population increase, reduction in land size and poor bean harvests over several seasons. The latter was suspected to be due to root rots and/or bean stem maggot (BSM), and hence the need to identify the production constraint(s) and evaluate possible management technologies.

Methods: Environmental Action Team (EAT), a local NGO working in this district, led efforts, in collaboration with CIAT, to establish the causes of poor bean crop performance. Participatory on-farm trials were conducted over two seasons in Meso, Nakwangwa, Kipsaina and Machungwa areas to determine production constraints and their importance.

Several farmers at Meso and Nakwangwa areas compared their local varieties with three root rot resistant varieties [SCAM-80CM/15 (released in Kenya as KK 8), MLB-49-89A (KK15), RWR 719 (KK22)] identified in Rwanda and now grown in root rot prone areas of Kakamega in western Kenya. Evaluation was made over two seasons, with some farmers integrating fertility improvement, mainly the use of farmyard manure (FYM) or compost.

Results and discussion: Root rots were observed in all four communities but were especially severe in Meso and Nakwangwa, wiping out local varieties regardless of the fertility management used. Bean stem maggot was also a problem across communities, particularly in late-planted beans during the first season and during the second season. Other bean diseases and pest observed were ascochyta blight, angular leaf spot, and aphids during the dry periods.

The comparison between root rot resistant and farmers' varieties was striking. The farmers' varieties died off in some farms, while root rot resistant varieties thrived in adjacent plots. Integrating fertility improvement resulted in 2 to 3 times more grain from resistant varieties compared to local varieties (Table 26). It is interesting to note that the resistant variety most liked by farmers was black seeded (MLB-49-89A), preferred for its early maturity and taste. However, RWR 719 was rated best for taste, while SCAM-80CM/15 was least liked because of taste and cooking time, despite being the most marketable as a Calima / rose coco type resembling GLP-2, a popular old variety. Some farmers have bulked considerable quantities of seed of resistant varieties, giving or selling the surplus to neighbors in response to increased demand.

To offer farmers more and diverse germplasm to overcome production constraints and also meet their preferences, initial evaluations of regional nurseries for root rot, angular leaf spot and bean stem maggot were carried out. Adapted and promising materials are to be evaluated in on-farm trials.

Table 26. Grain yield (kg/ha) of root rot resistant varieties compared with farmers' varieties under fertilized and unfertilized condition in on-farm trials.

Seed type	Yield (kg/ha)			
	Unfertilized		Fertilized	
	1st season	2nd season	1st season	2nd season
Farmer variety	550 a[1]	247 a	605 a	797 a
SCAM-80CM/15 (KK8)	1461 c	717 a	1903 b	1902 bc
MLB-49-89A (KK15)	1064 b	1209 b	2128 b	2408 c
RWR 719 (KK22)	1230 bc	1050 b	1919 b	1889 b

[x] = means in a column followed by the same letter are not significantly different at P=0.01 (Fisher's Protected LSD)

Contributors: Beth Kirungu (EAT); R. Buruchara

Interactions between Fusarium wilt and bean stem maggot and nematodes.

Rationale: Fusarium wilt caused by *Fusarium oxysporum* f. sp. *phaseoli* is an important disease on some widely popular climbing bean varieties such G 2333 (Umubano) in the Great Lakes Region. Some of the few bush varieties resistant to root rots caused by *Fusarium solani* and *Pythium* spp. are susceptible to fusarium wilt. This vascular organism invades the plant via the root system and is likely to be influenced by infection and damage by bean stem maggot (BSM) and nematodes (*Meloidogyne* and *Pratylenchus* spp). Considering the widespread prevalence and importance of BSM and in some areas nematodes, knowledge on their interaction with fusarium wilt is useful in developing management strategies against the disease.

Methodology: Interaction between fusarium wilt and BSM and nematodes were determined using a variety G 2333 known to be very susceptible to wilt. Assessments were made over two seasons in trials on farms and the research station at PNL-Mulungu in DR Congo. Plantings were weekly over three weeks. Treatments included the control of BSM and nematodes by endosulphan and furadan, respectively, and effects on fusarium wilt were observed.

Results and discussion: Incidence and severity of fusarium wilt were significantly reduced in plots where BSM was controlled, particularly during the 1st and 3rd planting dates. A similar but not significant effect was observed with the control of root knot nematodes. This implies that the presence of BSM, and to some extent nematodes, results in an increased incidence and severity of fusarium wilt. In developing management practices to control Fusarium wilt, the possible influence of BSM and nematodes have to be considered.

Contributors: K. Ruhebuza (PNL, Mulungu), R. Buruchara , NARO, HRI and NRI.

Epidemiology of bean root rots: characterization of Pythium and Fusarium spp associated with bean roots in Uganda

Rationale: Some of the management efforts against soil-borne diseases are directed at inoculum levels, which can influence disease incidence and severity. Elucidating the identity of the disease complex (*Pythium* and *Fusarium* spp.) and their interactions with biotic and a biotic factors are essential to appropriate management strategies. This requires development and use of diagnostic tools for identifying and quantifying components of the pathogen complex.

Methods: Under a DFID supported collaborative project between National Agricultural Research Organization (NARO, Uganda), Horticultural Research International (HRI) and Natural Resources International (NRI) of UK, and CIAT, studies were initiated to characterize *Pythium* and *Fusarium* species associated with root rot diseases in Uganda, where root rots have become increasingly important. Plant and soil samples were collected from the districts of Kabale and Kisoro district in the southwest and Mbale in Eastern Uganda. Initial characterization was based on cultural and morphological characteristics, following isolation on semi-selective media and preliminary molecular characteristics for Fusarium.

Results and discussion:

Pythium spp: A total of 47 isolates have been characterized using morphological structures (sporangium presence, form, and size; size, wall thickness and plerotic conditions of the oospore; oogonium location, ornamentation, size, and shape; and the number, origin and morphology of the antheridia) to determine the predominant *Pythium* species in Uganda.

Morphological characterization indicated that *Pythium* species include *P. sylvaticum* (5), *P. oligandrum* (3), *P. rostratum* (1) and HS group (3) from Mbale; *P. sylvaticum* (2), HS group (1), *P. spinosum* (2) and *P. ultimum* (1) from Kabale; *P. irregulare* (1), *P. echinulatum* (1) and suspected *P. salpingophorum* (1) in Kisoro. Twenty-two isolates that were difficult to identify using morphological structures were categorized in three groups. Isolates are to be further characterized using pathogenicity and molecular methods. *Pythium* species whose DNA base sequences and primers are known will be the basis for molecular characterization.

Fusarium spp: Cultural characteristics suggested that most of about 100 Fusarium cultures collected were *F. oxysporum*. Most failed to grow on NSB, a semi-selective medium for *Fusarium solani*. A few grew on NSB and some of these exhibited *F. solani* f.sp *phaseoli* characteristics.

Two methods of DNA extraction were compared: the SDS-phenol method and direct boiling of spores at 96°C for 5 minutes. Both methods yielded amplifiable DNA, though boiling spores was very quick and could facilitate DNA extraction from many fungal samples in a short time. Two primer pairs, F. SOLITS lF/5R and 442/444, were able to discriminate clearly between *F. solani* and *F. oxysporum*, respectively. Discrimination using RFLP was also attempted using two restriction enzymes: *Hae*III and *Msp*I. Although both easily differentiatedbetween *F. oxysporum* and *F. solani*, *Hae*III was a better choice because it digested both *F. solani* and *F. oxysporum*; *Msp*I produced a digestion product only from *F. solani*.

Contributors: J. Mukalazi, G. Tusiime and F. Opio (NARO); J. Carder, G. White (HRI); and R. Buruchara.

Understanding bean stem maggot ecology

Rationale: Population patterns and species dominance among bean stem maggots (BSM), the most important insect pest of beans in Africa, are believed to be changing. For example, *O. spencerella* is gaining dominance in Ethiopia, an area where it was previously unknown. BSM ecology is also not well understood, leading to difficulties in predicting populations and incidence of damage.*Methods*: Beans were planted at Selian, Tanzania, our regional base for IPM research, weekly throughout the year from November 1999, and BSM species composition was monitored.

Results: *O. spencerella* was dominant through the year, with a small and brief reversal in species dominance in early to mid May (Figure 11). BSM populations dropped sharply in late February to early March, just before the rains and planting of beans started. The populations picked up again in late April to early May. This period of population depression corresponds to the bean planting period and explains why BSM is less serious at Selian in the March planted crop, while the late planted crop is more severely attacked. The population dynamics appear to have remained the same, as Swaine (1968)[1] and Wallace (1939)[2] observed the same trend. However, there appears to be shift in species composition, with *O. spencerella* gaining complete dominance over *O. phaseoli*; previously strong reversals in species dominance were not observed. Factors influencing the population change are under investigation.

[1] Swaine G. 1968. Studies on the biology and control of pests of seed beans (*Phaseolus vulgaris*) in northern Tanzania. Bull. Ent. Res. 59:323-338

[2] Wallace GB 1939. French bean diseases and bean fly in East Africa. E. Afr. Agric. J. 5: 170-175

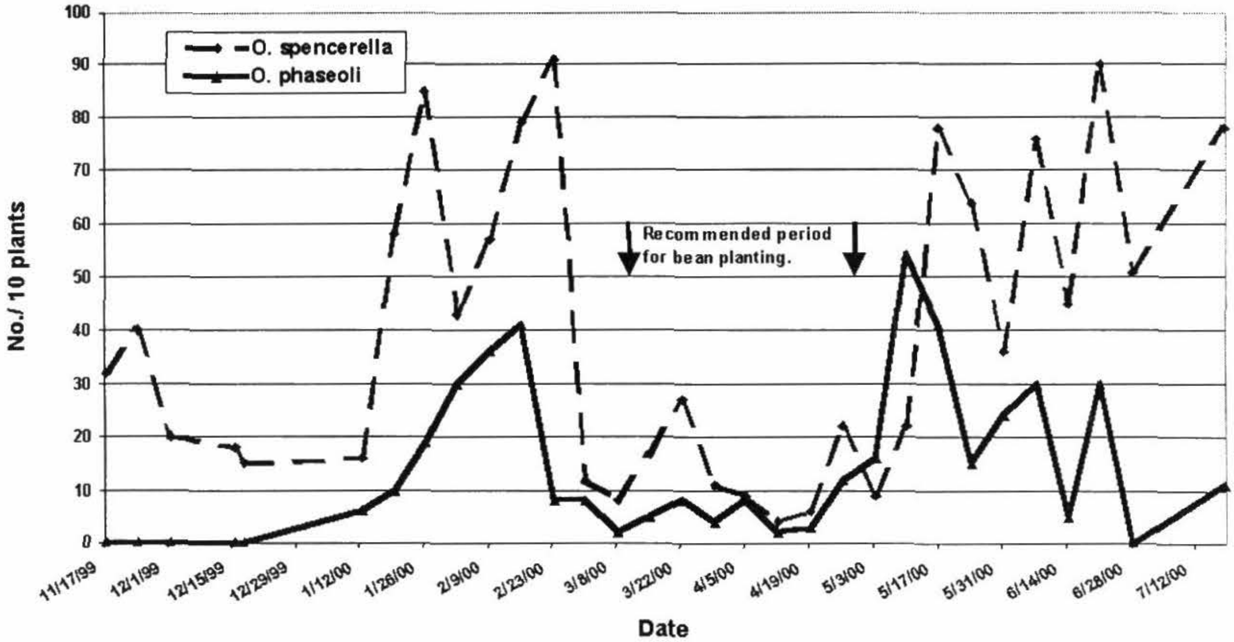


Figure 11. Bean stem maggot population dynamics at Selian, Tanzania, 1999/2000.

Contributor: K. Ampofo

Effect of bean companion crops on pest and natural enemy populations

Rationale: Considerable production of beans comes from intercropping associations used by small farmers in risk aversion and other strategies. Better understand of the multiple interactions among beans and various companion crops could aid in IPM.

Methods: Eight crops commonly grown with beans were selected for a study of their effect on bean colonization by aphids, BSM, whiteflies and thrips. Companion crops (cowpea, soybean, kale (*sukumawiki*), bell pepper, onion, tomato, maize and sorghum) were planted in advance of beans. Pest colonization was monitored with traps and other sampling procedures.

Results and discussion: Tomato appeared to be attractive to BSM and white flies: populations of these pests were highest in this intercrop with beans. Cowpea appeared to attract BSM into the crop, and beans planted with cowpea were more heavily infested than beans alone. The other companion crops (soybean, pepper, maize, sorghum and onion) appeared to have no effect on BSM, but the maize/bean intercrop had less BSM, white flies and thrips, possibly due to the shading effect of maize over the bean canopy (this will be investigated in future trails). Intercropping with kale or pepper reduced white fly and thrips populations. Kale is known to have high levels of isothiocyanates that confuse certain aphids on their host location, although the effect of such volatilic compounds was not apparent in this trial. This study is in its initial stages and data reported here are preliminary.

Table 27. Influence of companion crops on pest activity in bean intercrops.

			Pest activity		
Companion crop	BSM(% infestation)	BSM per plant	Whitefly per trap	Aphids per trap	Thrips per trap
Cowpea	93.3 a	3.7 b	4.7 bc	3.0 b	27.7 a
Soybean	86.7 a	2.5 bc	5.0 bc	0.7 b	16.3 abc
Maize	60.0 b	1.7 c	1.2 d	0.3 b	3.3 d
Sorghum	86.7 a	2.9 bc	4.1 bcd	2.7 b	13.7 bcd
Tomato	100.0 a	5.5 a	8.8 a	2.0 b	7.0 cd
Pepper	86.7 a	2.9 bc	2.9 cd	1.3 b	7.7 cd
Onion	73.3 ab	3.4 b	8.0 a	3.7 ab	15.7 abcd
Kale	73.3 ab	2.1 c	3.0 cd	7.3 a	8.7 cd
Bean sole (untreated)	86.7 a	2.5 bc	8.3 a	1.3 b	17.3 abc
Bean sole (treated)	73.3 ab	2.3 bc	6.4 ab	3.7 ab	26.0 ab
$LSD_{.05}$	25.8	1.5	3.3	4.2	12.5

Means in the same column followed by different letters are different at the 5 % level.

Contributor: K. Ampofo
Collaborators: B. Torto (ICIPE) and L. Wadhams (IACR-Rothamsted)

3.3 Design efficient methods for systems improvement

Achievements:

- Preliminary results from a study of the capacities of two contrasting Ethiopian highland farming systems to satisfy human nutritional requirements showed that better food composition was available in Areka than in Ginchi, related to Areka's crop diversity.

- A participatory methodology developed and tested in Ethiopia for understanding the social dynamics of technology diffusion

- Farmer research groups (FRGs) proved effective at reaching people often neglected by formal research and extension services: in Uganda, women constituted 67% of membership in mixed groups as well as forming some separate groups, and resources-poor farmers represented 14% of overall membership.

- Performance of FRGs was better in small groups having strong group identity and committed leadership, in communities committed to collective action, in those that broadened the scope of activities well beyond research and experiments, and where researchers showed unusual commitment.

- Core issues in NRM resources sharing in SW Uganda were identified as intra-, inter- and supra-household gender-related conflicts (men and women, household versus community), common property resources such as wetlands and grazing lands, hillsides management conflicts (destruction of terrace bunds), and crop raiding by animals.

- Simple and short-term experimentation (crop varieties, seed, fertilizer) provides good entry points to sustain farmer participation, but investment is needed in the quality of participation and identifying entry points and trade-offs to move on to NRM research and NRM conflicts.

Human nutrition in two Ethiopian farming systems

Rationale: In East Africa the food situation is continuing to deteriorate, in nutritional imbalance (quality and distribution) as well as in quantity, for many people with limited means to benefit from liberalised markets. In Southern Ethiopia, one of the region's poorest, root crops provide an energy-rich diet, but protein and micro-nutrient deficiencies are likely. Animal protein is inadequate or is used as a scarce source of cash. Analysing a household's production of nutrients could be valuable in guiding intensification of those systems in which markets are less important than securing subsistence, for example by raising with farmers options for adjusting crop combinations, increasing the land area allocated to crops rich in requisite nutrients, or introducing dietary supplements.

Methods: Areka and Ginchi are two of the eight AHI benchmark sites for integrated ecoregional research in NRM issues with national partner institutions. Ginchi, 80 km west of Addis Ababa, represents Ethiopia's upper highland plateaux (2,800m), with average farm size of 3.0 ha and a watershed dominated by a barley-fallow-barley system in which the range of crops is restricted by low mean temperatures. Areka, isolated from regional markets at 430 km southwest of Addis Ababa and the base for CIAT support to AHI in systems intensification, is characterised by a multiple cropping system with strong perennial components, high population pressure and average land holdings of less than 0.5 ha; maize is the predominant cereal.

We hypothesis that households in Areka experience food shortage while households in Ginchi experience both nutritional imbalance and food shortage. The other principal question to be answered is in which months farmers of the two contrasting systems experience severe food imbalance? In this initial phase of the study, we assembled and analysed secondary sources of date for each area on crop and household land areas, yields, and crop nutrient composition. Ethiopian crop and food compositon tables were consulted (EHNRI and ILRI, 1998). A food consumption index, indicating the relative frequency of consumption of each food item over the course of the year by Areka and Ginchi households, was calculated for each food item and month from frequencies of consumption and number of households consuming that food item in the month. Sample household budgets and food security were estimated.

Results and discussion: Table 28 shows land allocation to various food crops. In Ginchi, the largest proportion of land is allocated for barley, followed by wheat and potato. About one third of the land holding is left fallow to restore soil fertility. The system furnishes mainly energy-rich crops (barley, wheat and potato), and hence protein and vitamin deficiency is to be expected.

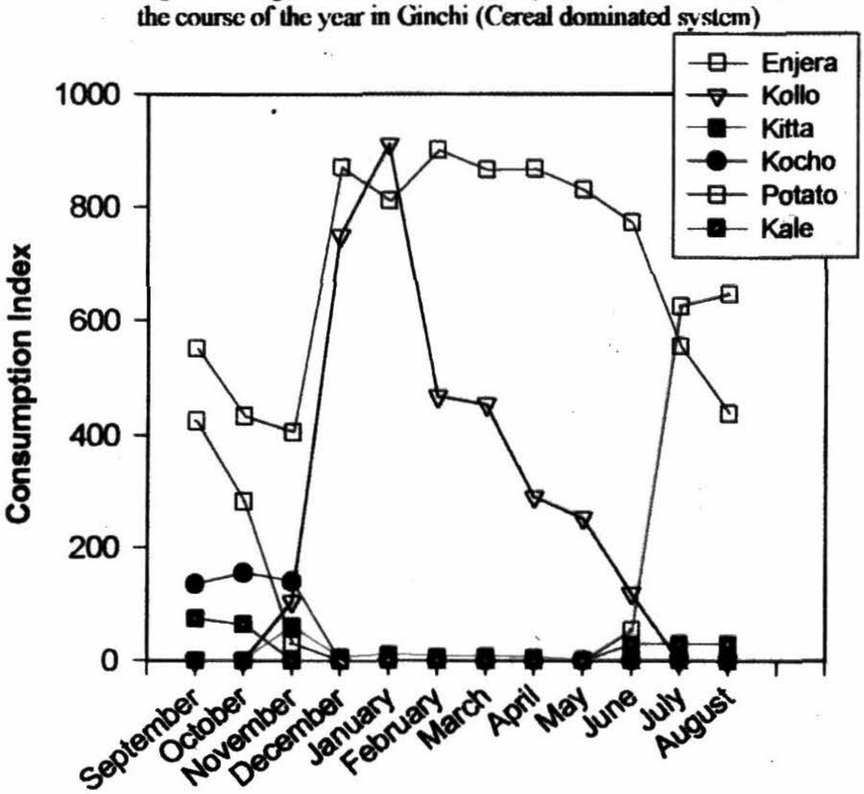
Table 28. Household crop land allocation in Areka and Ginchi benchmark sites, Ethiopia.

Areka		Ginchi	
Crop	Crop area (m²)	Crop	Crop area (m²)
Enset [1]	1,100	Barley	8,100
Coffee [1]	831	Wheat	5,400
Maize	1,970	Potato	2,250
Sweet potato[2]	168	Enset	30
Wheat/Teff	351	Onions	4
Pea [2]	52	Kale	4
Potato/beans	350	Fallow	11,700
Total area (m²)	4,822	Total area (m²)	27,488

Notes: [1] Enset and coffee are interplanted with beans, sweet potato, kale and/or maize.
[2] Sweet potato and pea are commonly planted as relay crops in maize.

Potato is important to fill the food gap that appears shortly before the main harvest, both in Areka and Ginchi. The Areka system furnishes energy-rich (sweet potato, enset — the false banana, *Ensete ventricosum*, potato, maize), protein-rich (beans and pea) and mineral -rich crops,

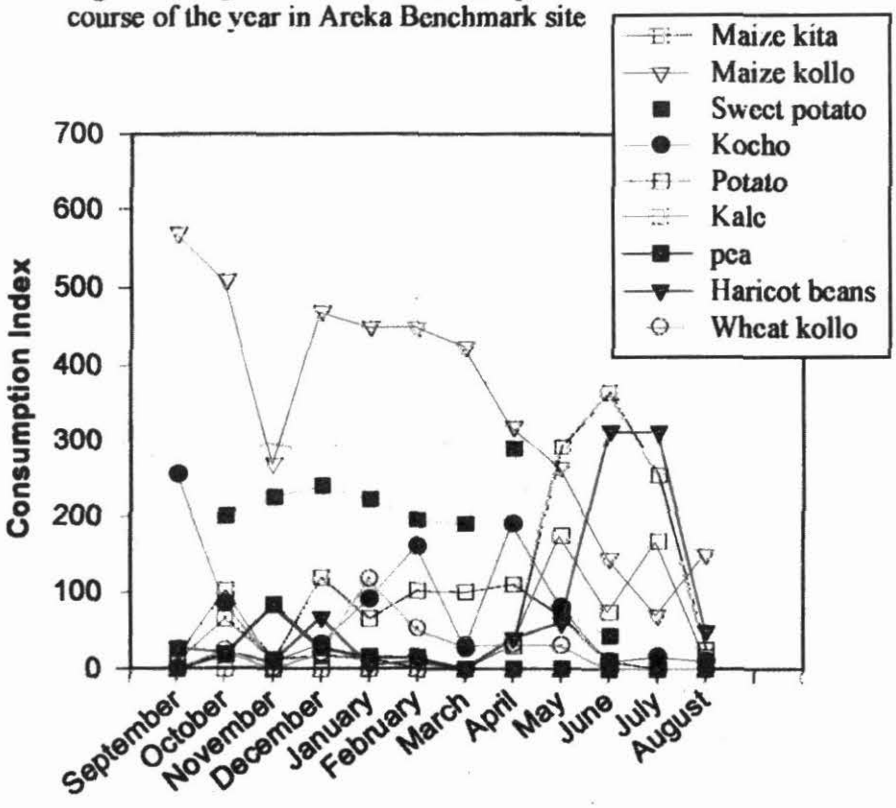
Fig. 1 The degree and time of consumption of various food items over the course of the year in Ginchi (Cereal dominated system)



which at least theoretically could furnish a balanced diet. However, the consumption pattern follows the production pattern in both sites. Hence, higher food diversity *per se* did not assure a balanced nutrition for the household.

Figures 1 and 2 show that, through most of the year, households in both sites consume few food items. In Ginchi, enjera (from tef, *Eragrostis tef*) and roasted barley (*kollo*, with high energy content) were the main food sources from November to June. Enjera is commonly accompanied by pea source (*shiro wat*), but the amount consumed is relatively small. *Enjera* and *kollo* are replaced by potato from July to September (Fig 1). Potato is commonly accompanied by kale, which has a higher content of vitamins, mainly Vitamin C. Bread from enset (*kocho*) auguments

Fig.2 The degree and time of consumption of various food items over the course of the year in Areka Benchmark site



potato in September and October (Table 26). It is tempting to conclude that August to November furnish better quality nutrition than the harvest months of November and December (Fig.1).

Fig. 2 shows that better food composition was available in Areka than in Ginchi, throughout the year. This was mainly because a greater variety of crops are grown, thanks to moderate temperatures. The highest consumption index was obtained by roasted maize grain (*kollo*), followed by sweet potato. All households almost throughout the year consume roasted maize, an energy-rich food, although the consumption rate declines between June and August. Maize bread (*kitta*) and sweet potato accompany roasted grain for at least eight months of the year (Fig. 2). Like Ginchi, potato consumption at Areka is augmented by kale between June and August, when a protein-rich dish (roasted phaseolus beans) is also available.

Household budget and food security: Areka farmers are not necessarily consuming their own farm products. Farmers brought farm products to market for two main reasons: when in need of cash for taxes, holidays, fertilisers or social commitments; and when needing to buy food items not produced on their farm. Table 29 indicates that farmers obtained most of their cash income from crop sales. The amount of food produce that they brought to market was more than the amount of produce they bought from market to fill household food deficits. More than 40% of the annual expenses was used for buying food, followed by fertilizer cost and holidays. Meskel, the finding of the True Cross, is the main annual feast in Areka, and farmers invest whatever money is at their disposal for this exceptional week.

Table 29. Sample expenses, income and income sources of two households in Areka, Ethiopia.

Expenses	Farmer 1	Farmer 2	Income sources	Farmer 1	Farmer 2
	Food deficit period (3^{rd} - 6^{th} month)				
Buying food	495	400	Crop sale	685	550
Buying fertilizer	320	140	Retail market	240	360
Holiday	250	220	Selling animals	?	?
Tax	37	32			
Social	115	-			
Total expense	1127	1092	Total income	925	910
			Deficit	202	182

Note: Expenses and income in Ethiopia Birr (approximately US$ = ETB 8)

Farm produce brought to market could have covered the food deficit and all expenses in the case of the two farmers in Table 29. However, it failed to do so, mainly because farmers brought their produce to market in harvest months when farm products are cheap, and purchased food for the household during the hunger months of March to June.

Future plans are to estimate actual yields of each crop in both research sites, record what farmers are growing as relay crops (in Areka) so as to better document annual food production, calculate energy and nutrients furnished by the existing systems, and compare with recommended daily allowance. The data will be used to model an improved cropping strategy.

Contributor: Tilahun Amede (CIAT/AHI)
Collaborators: Mulugetta Diro and team (Areka Research Center); Bekele Kassa and team (EARO-Holetta); B. McIntrye (Rockefeller Foundation); A. Stroud (ICRAF/AHI).

Understanding the social dynamics of technology diffusion

Rationale: Researchers involved in community-based participatory research typically work with selected farmers and assume that new technologies developed together with those farmers will spread rapidly to other farmers through social and other networks and processes. This process is not well understood and there is little research on factors that influence diffusion.

Methods: Under an internship program, a Canadian social scientist spent one year examining the social dynamics of technology diffusion in two communities in the central Rift Valley of Ethiopia. The two communities, Wolencheti and Boffa, are research sites for the Participatory Research for Improving Agro-Ecosystem Management (PRIAM) project. Ethnographic approaches were used to understand farmers' social networks and a participatory tool, technology diffusion mapping, was developed and used to trace the spread of new technologies. Wealth ranking exercises provided information on the wealth status of project participants.

Results and discussion: Contrary to expectation, relatively few farmers working with the PRIAM project shared technologies with farmers living in the same village. This was due to a lack of a sense of community or village. Instead, the pattern of technology diffusion reflected the types of social networks and traditional institutions which farmers invest in, and these cut across village boundaries and are imbedded in multiple kinship and friendship ties. Farmers mainly shared technologies (seed of modern varieties and farm implements) with relatives, close friends and members of associations to which they belong (mutual aid funeral associations, friendship networks, labor exchange groups, oxen sharing groups, savings societies).

These findings suggest the need for researchers working on community-based participatory projects to rethink or make explicit their assumptions regarding social organizations and implications for the diffusion process. One area to explore is using social networks and existing associations as potential entry points for research, development and extension activities.

Technology diffusion mapping proved to be an effective tool for tracking the diffusion of new technologies over time. It can also be used as a diagnostic or rapid appraisal technique to identify and analyze the social relationships, networks and institutions found in rural communities and their functions with regard to resource sharing and coordinating collective action. Farmers can do the mapping on their own and find the exercise stimulating. This tool is appropriate for tracking the spread of recently introduced technologies (no more than 5 years); tracking older technologies makes the map too complex and farmers are unable to remember with whom they shared technologies.

Contributors: A. Adamo, S. David.
Collaborators: Sisay Tekleselasie and Tassew Biru (FRG Chairmen of Wolenchiti and Boffa Peasant Associations, respectively); Melesse Temesgen (EARO).

Farmers' organizational skills for participatory research

Rationale: In recent years we have increasingly worked through community-based approaches to catalyse more cost-effective and relevant farmer participation in research. We have supported the development of farmer research groups (FRGs) linked to multi-institutional NARS teams at sites in 6 countries under the Participatory Research for Improved Agro-ecosystem Management (PRIAM) Project and the African Highlands Initiative (AHI). The function of FRGs has generally been to plan, conduct, monitor and evaluate trials, disseminate information and technologies to the wider community, and catalyze community development by acting as a bridge between researchers and the community. However, our success with FRGs has been variable. We need methods to distinguish which kinds of group are appropriate for which types of task so as to develop more effective ways of organising participatory research, building farmers' capacity to experiment and innovate, and facilitating sharing of experience, knowledge and skills among farmers.

I. PRIAM in Ethiopia:

Methods: Researchers investigated over the course of one year the activities of two FRGs in the central Rift Valley of Ethiopia (Wolencheti and Boffa) through group discussions and an evaluation exercise using a modified logframe as a participatory tool. FRG members analyzed their ability to meet group objectives and identified potential strategies to better enable the groups to meet their objectives. Other topics covered during group discussions included leadership, the cohesiveness and problem solving capacity of the groups, benefits and drawbacks of working as a group, the relationship between the FRG and researchers and the community. The activities of FRGs were also evaluated using the logframe evaluation tool by farmers who were not directly involved in the PRIAM project.

Results and discussion: FRGs in the two communities achieved different levels of success in carrying out their functions. The FRG in Wolencheti experienced measurable success in working as a group and achieved its objectives mainly due to its strong and committed leader. Farmers reported that the presence of the FRG has improved the quality of on-farm experimentation, and the capacity of farmers to monitor and evaluate trials and communicate results to farmers outside of the project. Moreover, Wolencheti farmers maintained that the presence of the FRG ensured a more collegial relationship between farmers and researchers. By contrast, the FRG in Boffa experienced considerable difficulties in functioning as a group and in meeting its objectives. Members reported that the group suffers from poor leadership and group cohesiveness and lacks adequate problem-solving initiative and capacity.

The experience of the two groups suggests that strong and committed leadership and a strong group identity (members who think of themselves as a group and work together) are important. To strengthen the capacity of FRGs, researchers need to assist members to organize rules and regulations defining the roles and responsibilities of members and leaders, develop mechanisms for monitoring and enforcing regulations, and generally improve group functioning and problem-solving capacity.

Contributor: A. Adamo
Collaborators: Sisay Tekleselasie and Tassew Biru (FRG Chairmen of Wolenchiti and Boffa Peasant Associations, respectively); EARO.

II. AHI in Uganda:

Methods: This study is being carried out with AHI partners at the Kabale benchmark site in south-western Uganda. A participatory learning and action research approach is used to understand and facilitate FRG dynamics and participatory research processes with a sample of 40 farmers' groups, group leaders and participating farmers as well as non-participating farmers drawn from communities served by a range of partner institutions. Participatory monitoring and evaluation tools were combined with semi-structured interviews, and a sub-sample of 21 FRGs was selected for in-depth monitoring, facilitation and documentation. The study uses the "quality of participation" framework to assess systematically FRG performance and identify their strengths and weaknesses.

Results:
Profiles of farmers research groups: Many research and development organizations in Kabale use different types of participation and variants of farmers' organizations. The majority of the 21 FRGs in the AHI site were newly formed groups (71%). FRGs were either mixed (76%) or exclusively women's groups (24%); women represented 67% of farmers in the mixed groups.

Table 30. Profile of farmers research groups in Kabale, Uganda.

Farmer group characteristics	N= 21
Number of mixed groups	16 (76%)
Number of women's groups	5 (24%)
Number of men's groups	0
Proportion of women in mixed groups	67%
Average number of members	28 (range 10-65)
Number of pre-existing groups	6 (29%)
Number of new groups	15 (71%)
Average number of technologies	2.1 (range 1-7)
Average number of experiment seasons (2 seasons/year)	3.5 seasons (range 1-8)

These FRGs have conducted on the average three seasons of experiments, evaluating crop varieties, cropping methods (spacing, intercropping), integrated pest management of potato bacterial wilt and bean root rot. Soil fertility management experiments were rather limited. Experiments are conducted by the group on a collective plot, often donated by group members or rented by the group.

How does participation occur in FRG?

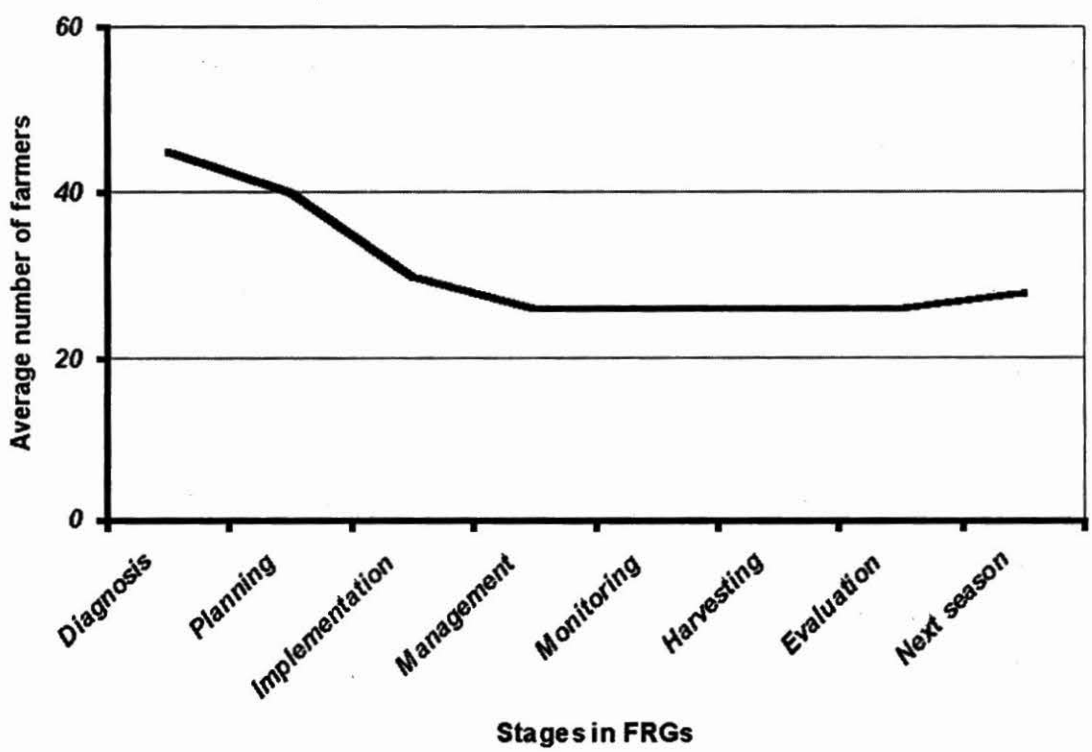
The initial hypothesis was that participation in groups would tend to follow the normal adoption curve, rising slowly at first, accelerating to a maximum, and then increasing at gradually slower rates.

Results showed that farmer participation in FRGs tend instead to follow a shallow "U" shaped curve (Figure 9), with high participation at the initial stages of the process, followed by dramatic decrease as many farmers drop out, and slow increases towards the end of the first season. Many farmers participated in the diagnosis and group formation stages expecting free handouts (fertilizers, seeds, pesticides and credit...). They later dropped out when they discovered that there were no immediate personal benefits and free handouts.

Who participates?

Initial hypotheses were that (1) FRGs may exclude certain categories of local people, particularly women and poor farmers who may not be able to absorb the costs of participation and experimentation; (2) men tend to dominate community organisations (and therefore FRGs) as they are more likely to have land and other resources for experimentation and to be in contact with external (research) organisations; and (3) resources-rich farmers are likely to dominate FRGs as being better able to absorb the costs of participation and experimentation.

Figure 9: Pattern of Participation in Farmers Research Groups



There was a significantly higher participation of male farmers at the beginning of the process, compared to women. However, as the process progressed, the proportion of men decreased while the proportion of women increased significantly. Women represented about 67% of farmers in mixed groups, and 24% of the FRGs were exclusively women's groups. By contrast, there were no exclusively men's groups, and men were reported to have lower participation rates in mixed groups. The higher participation of women was explained by their dominant roles and responsibilities in crop production. Further, groups are known to provide women with a legitimate social space that fosters a sense of solidarity and collective action.

Wealth ranking exercises and interviews with FRG members showed that the majority of FRG members were in the middle category (64% compared to 49% in the wider community); the poor were under-represented (Table 31). While resources-rich farmers were not over-represented numerically, they and educated farmers dominated the leadership positions in FRGs committees.

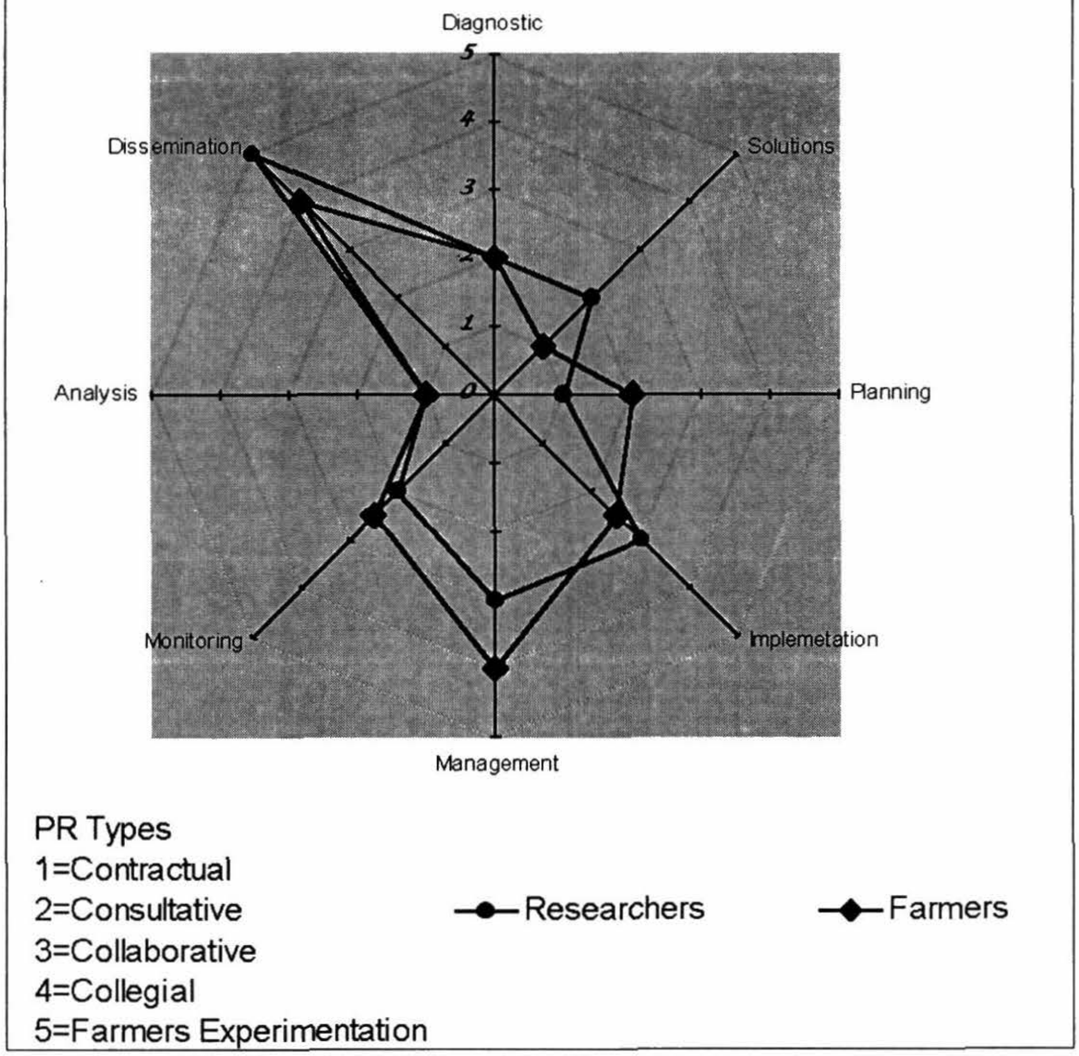
Table 31. Distribution of FRG members by wealth categories.

Wealth categories	FRG members (%)	Within the wider community (%)
Group 1: Resource-rich farmers	22	26
Group 2: Middle category	64	49
Group 3: Resources-poor farmers	14	31

Types of Participation

The initial hypothesis was that the older the FRG, the more collegial the type of participation and the more successful the FRG. The study is showing that, typically, farmers' participation occurs in the stage of technology evaluation and dissemination, regardless of the years of experiment. Analysis of the types of participation (Figure 10) showed that, in general terms, farmers' participation is of a consultative type. However, farmers in successful FRGs are gradually taking over control of some stages in the research process, often without researchers' knowledge. Although there are good opportunities to give more roles to farmers (such as monitoring, evaluation, trial management), researchers are still applying contractual and consultative types of participation. There is an urgent need to support research teams and farmers to improve the quality of participation, moving towards a more collegial type of participation.

Figure 10: Types of participation in Farmers Research Groups



Discussion:

- Effects of FRG: Some indications of developing impacts are gradually emerging:
- Reaching Women and the Poor: FRGs proved to be an effective means as these people are often neglected by formal research and extension services. Women constituted about 67% of FRG members in mixed groups and have formed their separate FRGs without proactive intervention from researchers. In some cases, women have formed their separate groups, keeping one or two men as "advisors" for public relations purposes. Resources-poor farmers represented 14% of FRG members who would otherwise be bypassed by conventional approaches.
- Building social capital: FRGs are increasingly becoming vehicles through which farmers are pursuing wider concerns, initiating new activities, organizing collective action among members and extending relations and linkages with external organisations. New groups and "second generation" farmers' organisations are emerging and asking to be included in AHI.

FRGs also provide women with legitimate social space to widen their social interactions and organize collective actions.

- FRGs seem likely to help build "bridging" social capital through regular farmers' exchange visits and by linking farmers to other formal and informal institutions.
- Enhanced human capital and farmers' innovation: Farmers are collectively acquiring new skills and new knowledge, gaining confidence and self-esteem. A considerable number of FRGs and individual farmers have initiated their own experiments in their individual fields.
- Farmers' innovations and commitment to experimentation: Two seasons of experiments were badly affected by prolonged drought. While scientists were easily discouraged by the failures of experiments, farmers were willing to try again. However, so far very few modifications or adaptations have been made by farmers. Instead, some groups have established their own experimental plots where they made modifications, often without the knowledge of scientists.
- Farmers have understood experimentation as a learning process through small plots, and were more interested in learning good management practices. By contrast, in some other FRGs farmers were more motivated by free improved seeds every season, were more dependent on researchers and have not been able to produce their own seeds after about 4 seasons of experiments.
- Learning with spill over effects: Technologies (seeds) and skills are gradually shared with other community members, through farmer-to-farmer exchanges and sale of seeds. Yet, in some FRGs there is a tendency to exclude non-group members in an attempt to monopolize the benefits (improved varieties), in reaction to the ridicule from other community members at the initial stages.

<u>Factors affecting FRG performance</u> include:

- Larger FRGs showed lower participation rates, higher rates of drop out, and higher numbers of inactive members which adversely affected group performance and cohesion. Leadership conflicts were common in larger groups.
- Social capital (relations of trust, cooperation, norms and regulations, social interactions, group dynamics and collective action) was higher in smaller groups with a stable membership and leadership.
- FRGs tended to be more successful in communities where there was local commitment to collective action and strong social capital. Similarly, FRG was found to be a very effective mechanism for building human and social capital in the communities.
- The successful FRGs were those that broadened the scope of their activities well beyond experiments. They were gradually becoming self-sustaining by diversifying their group activities beyond initial research activities and experiments.
- Personal commitment (or its lack) by researchers and regular monitoring were key in explaining FRG success ("failure"). FRG as an approach has great potential for catalyzing the participation of farmers as partners in research and development activities. However, achieving such potentials requires skills, capacities and personal commitment that researchers need to internalize. "*...The main obstacle in providing farmer participatory research is the research workers themselves...*" (R. Booth, in Selener, 1999).
- Simple and short-term experimentation on crop variety evaluation, seed multiplication and fertilizer application were good entry points to sustain farmer participation. Although the

4 Leaving land to fallow
5 Agroforestry.

Farms/households using four or more of these measures were considered "good" (class I). Farms using one to three measures were considered "average" (class II), while those farms not using any of these measures were considered "poor" (class III). Out of a total of 569 households only 20 (3.5%) were in class I, 55 (10%) in class II and the majority (494 or 87%) were in class III. Most farmers were not carrying out any improved soil fertility management practices, despite the previous work in this area (Table 24).

Table 24. Soil fertility management classification in Imanyiro subcounty, Uganda.

Village	Number of households			
	Using 4 practices (Class I)	Using 1-3 practices (Class II)	Using 0 practices (Class III)	Total
Buyemba	7	19	165	191
Kavule	9	28	94	131
Magada	4	8	235	247
Total	20	55	494	569

Contributor: A. Esilaba (CIAT-PE2/IP2)
Collaborators: J. B. Byalebeka (NARO-KARI); Nakiganda and S. Mubiru (NARO-NAARI); M. Mbalule (NARO-FORI); D.Ssenyange (Africa 2000 Network/UNDP); R. Delve (CIAT/TSBF); AHI; C. Palm (TSBF); IFDC, J. Ojiem (KARI); P. Ndakidemi (DRD).

Participatory monitoring and evaluation in integrated nutrient management

Rationale: The above project (preceding section) on "Improving integrated nutrient management practices on small scale farms in Africa" in its Uganda site identified very low uptake of five soil fertility management options as a constraint. Understanding reasons for this situation should help improve strategies for current and future work, here and probably elsewhere in Africa.

Methods: Participatory monitoring and evaluation was conducted, with 50 farmers from three participating villages in Imanyiro sub-county (Iganga District, Uganda) and 10 facilitators, on a series of on-farm INM trials being carried out this year by farmers characteristic of the three soil fertility management classes. The first farmer meeting session formed discussion groups by soil fertility classes (class I, II and III) identified during the diagnosis phase of PLAR. Farmers carried out a strengths/weaknesses/opportunities/threats (SWOT) analysis to evaluate project activities, assessed technologies using innovation assessment priority matrixes, reviewed project activities using a sustainability analysis matrix, assessed technologies in terms of their expectations and suggested improvements, and identified their lessons / skills learned, problems experienced, possible solutions, and training needs.

Results and discussion:

Farmers in class 1 (the few comprehensive adopters) ranked "deep tillage" with a hand hoe (rather than surface scrapping), composting and mulching as the best technologies. These technologies were assessed to be relatively cheap to implement, had the best rating on time to see benefits, and ranked as sustainable. The deep tillage trial improved water infiltration and improved crop yields. Mulching is a simple technology that improved banana growth despite the prevailing drought conditions. However, mulching materials are not easily available, so farmers proposed planting napier grass to provide mulch. Compost is cheap, simple and uses locally available materials, but transporting compost was a problem. Farmers proposed applying compost on vegetable gardens near the homestead. Farmyard manure (FYM), green manure, trenches and soil fertility test strips (SFTS - established to determine limiting nutrients) were ranked as average. FYM was considered to be cheap with rapid benefits, but was rated average for sustainability as most farmers do not own livestock. Green manure was inexpensive and sustainable, but took a long time to realise benefits; trenches had similar advantages but were difficult to implement due to the high labor and training needs. Soil fertility test strips were expensive but the benefits were observed in one season (Table 25).

Farmers in class 1 are relatively well endowed with resources and had been exposed to fertiliser use. They indicated that they could sustain the use of fertilisers. Busumbu and Minjingu (Prep-pacs) rock phosphate were, however, rated as average on sustainability, average to high on time to benefit and rather low on cost to implement, as these are new technologies introduced by the INM project. The farmers were not sure about availability and where to purchase rock phosphate fertilisers. Improved fallows were ranked as average on sustainability and cost to implement, but highly ranked on time to benefit. Although agroforestry was rated as highly sustainable, cost and time to see benefits were rated low.

Farmers in class 2 ranked deep tillage, farmyard manure and Busumbu rock phosphate as the best technologies. These technologies were ranked average to high on sustainability and high on cost to implement and time to benefit, although the little known technology of Busumbu rock phosphate was therefore rated low on cost. Green manure, mulching, trenches and Minjinhu rock phosphate were ranked as average. These technologies were rated high on sustainability (except for soil fertility test strips), low to average on cost to implement and low (improved fallow), average (compost) to high (SFTS) on time to benefit.

Farmers in class 3 (who had adopted little or no soil fertility management in the past) ranked green manure, compost, Minjingu rock phosphate and mulching as the best technologies (in that order). These were rated as average to high on time to benefit, variable (low to high) on cost to implement, and high on sustainability except rock phosphate as a new technology. The time to benefit, sustainability and cost of the technology were important criteria for these less-endowed farmers in class 3.

Other technologies were ranked lower. Improved fallow and agro-forestry were ranked low because they take time to show benefits and were perceived as costly. The less endowed farmers believed that they were not sustainable. However, the farmers indicated that they needed training in some of these technologies to appreciate the significance of these long-term technologies.

house, labor, cash (money), marital status, means of transport, level of food self sufficiency (food availability), crops grown and level of education (Table 22).

Social organisations in Imanyiro included 19 different groups, varying in size from a handful of members to an entire village. The groups were formed around issues such as women groups, church or religious groups, welfare, farmer research groups and fish farming. Only two organisations were identified in Kavule village: Kantu consists of a majority members of the village, while Kavule Development Group consists of all men in Kavule who plan development activities. However, these organisations do not interact with any external organisation.

Kantu group is also an important organisation in Buyemba village, where it has about 300 members who assist during funeral arrangements. Farmers identified ten social groups in Buyemba village, six being women groups and Ikulwe farmer participatory research group (IFPRG) being the most central organisation that cuts across most others and has about 50 members. IFPRG is a farmer research group that produces bean seeds and whose members conduct research on beans and green manures (canavalia, crotalaria, mucuna, lablab and tephrosia). Many farmers join IFPG because the organisation trains its members on modern

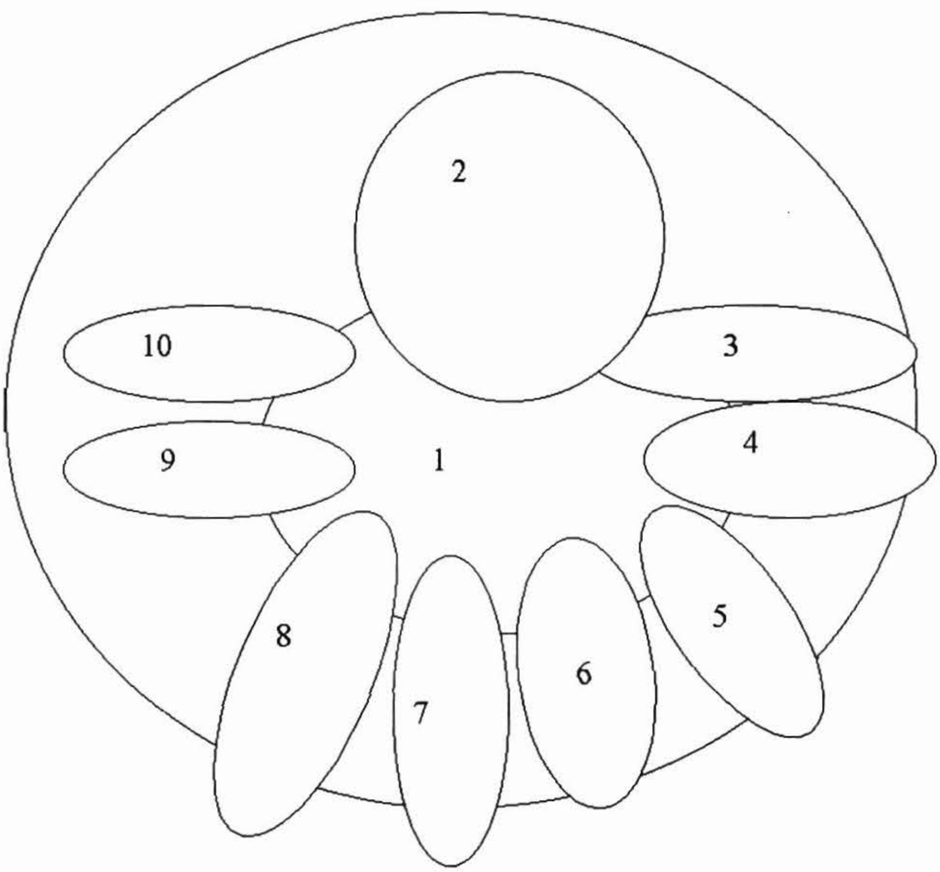


Figure 5. Social organisations in Buyemba village, Uganda.
Key: 1 = Ikulwe Farmer Participatory Research Committee; 2 = Kan
tu; 3 = Gema Kumwiino Society; 4 = Dembe Women's Group; 5 = Budala Women's Group; 6 = Muno Mukabi Mugeri; 7 = Bukawongo Women's Group; 8 = Lubu Women's Group; 9 = Igamba Kweyunga Women's Group; 10 = Kugumikiriza Women's Group;

farming and new technologies and provides farmers with new improved crop seeds. Most of its members are active, and only 20% members are passive. Its sources of information are NARO's Kawanda Agricultural Research Institute and Namulonge Agricultural and Animal Research Institute, and CIAT. Participating farmers voluntarily provide funds, labor and equipment for their research activities. Several internal and external organisations interact with Ikulwe farmer participatory research group.

Gender analysis was carried out in Kavule village with man and women farmers in separate groups. Access and control to resources and benefits profile was analysed and social relations of all the individual farm households of the village identified.

Soil diversity analysis and classification in Imanyiro led farmers to prioritise 12 soil fertility constraints. Drought was the main constraint, followed by lack of knowledge and skills on soil fertility management, low natural soil fertility, soil borne diseases and pests. The high cost of inorganic fertilisers was ranked number 6, while soil erosion and poor tillage methods were ranked as number 7.

The farmers identified 8 indicators of soil fertility decline: reduced plant growth, yellowing of plants, stunted crop growth, low moisture holding capacity of soils, increased incidence of pests, wilting of plants, increased weed growth and weed indicators. Farmers' ranking of causes of soil fertility are shown in Table 23.

Table 23. Priority ranking of the causes of soil fertility decline in Imanyiro subcounty, Uganda.

1.	Continuous cropping due to land shortage
2.	Poor soil fertility management
3.	Soil erosion
4.	Unsound / unplanned intercropping practices
5.	Poor management of crop residues and other available organic materials
6.	Poor tillage methods
7.	Lack of fallow in the rotations
8.	Nutrient mining through crop harvests
9.	Burning of bushes
10.	Lack of soil erosion control materials, e.g. vetiver grass planting materials

Strategies that farmers suggested to address the problem of soil fertility decline included use of green manure (e.g. mucuna and canavalia), inorganic fertilisers, agroforestry trees, fallow, compost manure, mulching, crop rotations and terracing. Evidently, farmers were aware of ways to improve soil fertility, partly on account of previous work by NARO and CIAT in the area.

Soil fertility management diversity among households in the study villages of Buyemba, Kavule and Magada was identified by farmers, and attributed to:

1 Use of fertilizers (both organic and inorganic)
2 Use of soil erosion control measures, such as vetiver grass strips, terracing and mulching
3 Use of green manures, such as mucuna, canavalia, crotalaria and lablab

Output 3. Sustainable bean production systems

Activity 3.1 Sustainable crop and soil management practices

Achievements:

- Farmers in a pilot ecoregional site in Southern Ethiopia became interested in intensifying their maize-based system by mixing an early maturing maize variety with their late variety, in a multi-purpose strategy to provide food and income in the "hungry gap" while opening a niche for relay planting of legume cover crops.

- In adapting earlier Ugandan results with fodder/soil improving legumes, Ethiopian farmers in the same area started evaluating seven species; canavalia was the best producer of biomass, and farmers ranked this and crotalaria as the best performing so far; trifolium and stylosanthes rejuvenated well after cutting.

- Participatory diagnosis of soil fertility in a pilot site in Uganda led farmers to prioritise 12 constraints (headed by drought, their limited knowledge and skills, and low natural soil fertility), to identify 8 indicators of soil fertility decline, and to start experimenting on selected options.

- At this site, only 3.5% of 569 households were using four of the five soil fertility management practices considered most promising during participatory planning; a smaller number were in use by 10% of households, while the majority (87%) were not carrying out any improved soil fertility management practices. Even this low level of adoption appears to reflect impact of earlier work in the area by CIAT and partners on green manures.

- Simple fertility-improving technologies that require little labor and only inexpensive, locally available resources were tentatively ranked as the best options among those being tested in farmer managed trials. Technologies that required purchase of inputs or were labor intensive rated as average. Long-term trials with no immediate benefits, like improved fallow and agroforestry, were ranked low at this preliminary stage.

Maize varietal mixtures to intensify a cropping system while minimizing risk

Rationale: Farmers managing maize-based systems in the region commonly experience food deficit before harvest. Growing an early maturing maize variety could cover this shortfall, but farmers prefer late maturing varieties because of their higher grain yield under favorable conditions. Earlier on-station investigations in southern Ethiopia (Amede, 1995) showed that growing a mixture of early and medium late maturing maize cultivars with synchronized flowering could improve yield by 60% over either variety alone in drought seasons, due to reduced competition for resources and improved seed set. Relay cropping also became possible once the early maturing variety was harvested.
If acceptable to farmers, these practices could overcome reluctance to adopt forage legume inter-cropping and provide a niche for soil improving legumes without losing maize yield.

Methods: Farmers' participatory research was initiated to test the response of 8 farmers in AHI's Areka benchmark site in Southern Ethiopia. A mid-late maturing maize variety (A511, 145 days to maturity, 245 cm tall) and an early variety ACV6 (120 days, 204 cm), found to be compatible in earlier experiments, were mixed at equal proportion and planted **simultaneously in April, a** month later than usual due to late onset of rain. Despite late start, rainfall was well above average, evenly distributed and sufficiently prolonged to support a full crop. Dry grain yield was calculated from yield components (cobs/plant, seeds/cob and 1000 seed weight), as farmers were interested in green cobs for sale and consumption.

Results and discussion: The information from on-station experiments was confirmed, in that A511 out-yielded mixtures in this favorable year with a long growing season. Although mixtures gave about 35% yield advantage over the early maturing variety alone, they yielded only 71% of a sole crop of the late variety.

The hungry gap before the main harvest in July was an especially difficult period for farmers this season, as it was said to be in half of all years in Areka. The early maturing component of the mixtures was ready to be consumed as green cobs in mid July, when no alternative food source was available. Farmers valued this attribute highly (Table 21). They also appreciated the extra income from selling green cobs that matured one month earlier than other farmers' crops, hence fetching about 50% higher price per cob. Income was twice that of selling dry grain at any time of year.

Table 21. Farmers' evaluation[1] of a mixture of early/late maize cultivars in Areka.

	Farmers				
Advantages or disadvantages	A	B	C	D	Mean (SE
Problem in preparation of mixture	3	2	3	1	2.25 (0.48)
Labor demand	2	2	1	1	1.50 (0.29)
Problem in harvesting	2	1	1	1	1.25 (0.25)
Getting compatible varieties	4	2	4	3	3.25 (0.48)
Affected by wild animals	5	5	5	5	5.00 (0.0)
Leave space earlier	5	5	5	5	5.00 (0.0)
Serve as support for intercrops	5	4	4	5	4.50 (0.29)
Minimises risk	4	3	3	4	3.50 (0.29)
Shortens hunger period	4	5	3	5	4.25 (0.48)
Yield advantage	3	3	3	4	3.25 (0.25)
Higher income	5	3	3	5	4.00 (0.58)

[1] Rating scale: 5 = high, 1 = low

A niche for introduction of legumes: Areka farmers became interested in this technology (Table 21) as the early maturing component left the land free two months earlier when harvested as green cobs. The late maturing stand could also serve as a support for intercrops. Farmers have started evaluating this effect on the performance of field pea and canavalia (for soil fertility improvement) as intercrops.

Possible reasons for non-adoption cited by farmers included vulnerability of an early maturing sole crop to wild animals (Table 21), as there was no other attractive crop available to be grazed at that time. The availability of compatible varieties and lack of seed were also mentioned as potential factors. Labor demand was not considered as a constraint. Future plans include assessing residual fertility effects of canavalia and pea intercrops, and their economic advantages, with a greater number of farmers. Solutions will be sought together with farmers to reduce the effect of wild animals.

Contributor: Tilahun Amede (CIAT/AHI)

Integrating herbaceous legumes into cropping systems of the East African Highlands

Rationale: Despite the potential role of legume cover crops (LCC) in soil improvement, the opportunity costs for labor, land and scarce rainfall can be too high for many farmers to perceive them as advantageous, particularly in the East African highlands where land use is intense and complex mixed cropping systems are practiced. Legume cover crops, unlike pulses, are unknown in Ethiopian cropping systems. Dual purpose legumes that offer food, feed and improve soil fertility can be attractive, but farmers tend to manage them for feed and food, rather than for soil fertility. This collaborative activity under AHI is designed to monitor the process of integration and develop a decision guide for farmers.

Methods: Under the AHI, we supported the introduction of seven species of fodder and soil improving legumes into farmers' fields at the Areka benchmark site in Southern Ethiopia. Farmer participatory research was designed to evaluate the adaptability and biomass production of the legumes, after a Farmers' Field School to acquaint farmers with baskets of options. Each species, namely *Trifolium quartinianum, Stylosanthus guianensis, Croletaria ochroleuca , Mucuna pruriens, Tephrosia vogelii, Vicia dasycarpa* and *Canavalia ensiformis*, was evaluated on 20 m^2 in three farmers' fields. Two farmers planted the legumes during the short rains in April and the third during the long rainy season in mid August 2000. One of the fields was extremely degraded and the farmer was on the verge of migration.

Results and discussion: Significant differences in biomass production among the legumes were recorded after four months. In this regard, canavalia was the best performing legume in the first 45 days, followed by crotalaria and mucuna. We invited farmers to the research plots to evaluate performance and choose their favorite legume for possible integration. They ranked canavalia and crotalaria as the best performing legumes. After three months of growth trifolium and stylosanthes rejuvenated well and showed considerable production (Fig. 3).

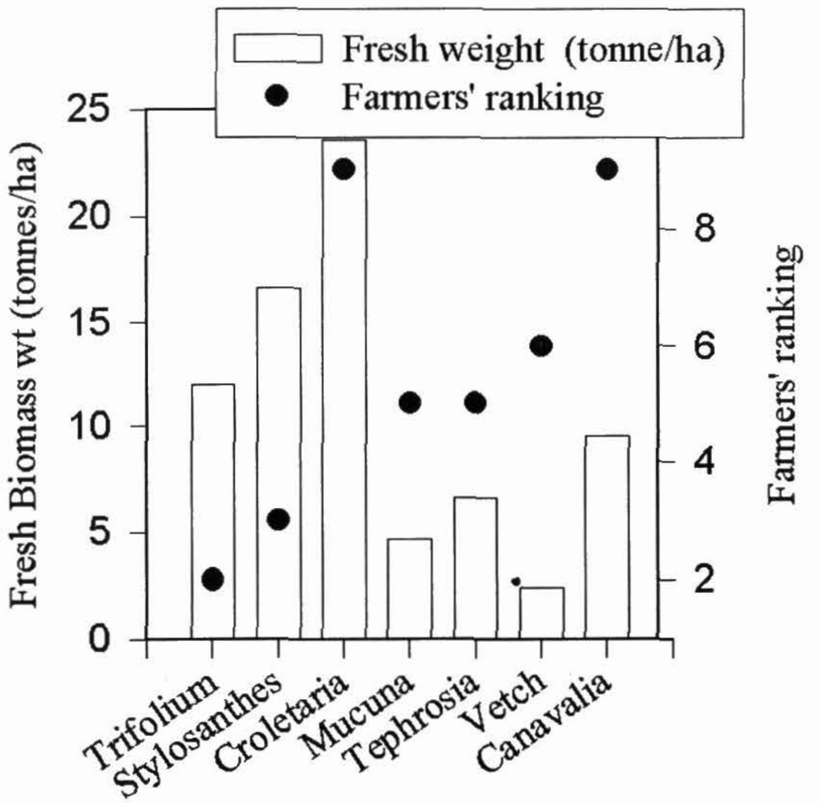
Mucuna performed poorly in these test sites, but better on fertile soils (data not shown). The legumes were chopped and incorporated into the soil of the same plots, and farmers have prepared the land for sweet potato in the coming short rains (October/November) to evaluate residual effects.

At the same time, about 25 farmers of different wealth strata have chosen and received seeds of canavalia and pea to integrate into their cropping systems. We have been monitoring what the farmers are doing with the two species. Preliminary data showed that farmers favor dual-purpose legumes for food/feed over purely cover crops — for example, they planted pea in fertile areas and canavalia in the degraded plots or borders. Farmers said that effects on the subsequent crop will dictate whether they accept the technology or not.

Potential factors posed by farmers for their reluctance to integrate LCCs into their farming systems were given as follows:

- Fear of risk of toxicity to animals and children;
- Single use (if no food or feed value);

Fig.3. Biomass yield and farmers' evaluation of soil improving and forage legumes grown under degraded soils. The legumes were four months old.



- Land scarcity in an already intensive system where most maize is already intercropped with other legumes and vegetables;
- Alternative multipurpose and more "useful" legumes exist (beans, pea, faba beans);
- Technology is not yet known;
- "I want to see it in other farmers' fields first".

Farmers are longing to see the effect of the various LCC species on the degraded land of one participant, and we will be monitoring their reactions. We will determine which of the above factors affecting non-adoption are important in which physical and socio-economic situations, monitor soil fertility status, and multiply LCC seeds for evaluation by more farmers.

Contributor: Tilahun Amede (CIAT/AHI)
Collaborator: Mulugetta Diro and team (Areka Research Center)

Improving integrated nutrient management practices on small farms in Africa

Rationale: Intensification of agriculture in the high-density sub-humid areas of Africa, generally without addition of plant nutrients, has resulted in 'nutrient mining' and subsequent land degradation. Nutrient depletion is a reversible constraint and high agricultural production can be realized with appropriate soil nutrient management, including integrated use of organic and inorganic sources. However, adoption of "improved" INM practices generally has been poor, and better strategies are required. Our hypothesis is that systematic learning with stakeholders, and farmers perceiving economic incentives, are necessary for changing practices. Skills in participatory approaches in research on complex technologies are still uncommon in Africa.

Methods: A project under the Soil, Water and Nutrient Management (SWNM) systemwide program, in partnership with TSBF (for Eastern Africa) and IFDC (for West Africa), aims to enable small-scale farmers to profitably reverse nutrient depletion of their soils by increasing their capacity to develop, adapt and use INM strategies, and to improve the participatory skills and tools of research and extension personnel to support that process.

This year the Participatory Learning and Action Research process (PLAR) (Defoer et al., 1996) was applied in Imanyiro sub-county of Iganga District. This site was selected because of earlier CIAT/NARO collaboration in participatory research and hence for being one of the few areas of Uganda where farmers have had exposure to soil productivity innovations.

A multidisciplinary team consisting of researchers, extension agents, NGOs and farmers from three parishes conducted the diagnostic phase. Facilitators interviewed more than 100 farmers, after initial team building and skills development. Participants reviewed the tools, including introductory village meetings, village maps, transects, organisation diagrams, wealth ranking and gender analysis, soil diversity analysis and farm classification, resource flow models and the closing village meeting. Farmer group and individual interviews were guided by a checklist proposed by facilitators and farmers that covered socio-economic issues, crop production, soils, land-use/agroforestry and livestock production. Farmers belonging to different soil fertility classes presented to other farmers their farm resource flow maps, identified and ranked main agricultural constraints, and proposed solutions.

Results and discussion:

Village territorial mapping showed that the upper parts of the catena were low in soil fertility, the main soil types were brown loamy soils locally known as "lukusikusi", and planted to bananas, coffee, maize, onions, cassava, beans and soybeans. Soil conservation measures included grass fallows and trees scattered on farmland. Severe termite damage to crops, mole rats, land overuse and fragmentation were the main constraints. Potential improvements suggested by the farmers were improved fallows as a low cost investment to improve soil fertility, and Tephrosia fallows to control mole rats (technologies introduced to the area by Wortmann *et al* 1998). Comparable assessments were carried out for other parts of the catena, with fertility and productivity increasing progressively lower down. In the valley bottom, soil fertility status was good but constrained by continuous cultivation without fertiliser use. Potential improvements suggested were introduction of leguminous fallows and use of both inorganic and organic fertilisers. Farmers identified 8 soil types based on soil color, texture and presence of stones or salt.

Table 22. Characteristics of wealth groups in Kavule village, Mayuge Parish, Uganda.

Indicators		Group 1	Group 2	Group 3	Group 4	Group 5
Land	Size	8-12 ha	3-5 ha	1.0-1.2 ha	0.6-1.0 ha	0-0.6 ha
	Frequency	Majority	Majority	Majority	Majority	Majority
Cattle	Numbers	Do not farm, these are traders	3-4 improved; 5-10 local	3-4 local	1-2 local	0
	Frequency	All	Majority	Majority	Majority	Majority
House	Type	Block walls, iron roof, ceiling	Block walls, iron roof	Block walls, iron roof	Grass thatch	Grass thatch
	Frequency	All	All	Majority	Majority	Majority
Labor	Type	Hired labor	Hired labor	Family labor	Family labor	Work as casual labourers
	Frequency	All	Majority	Majority	Majority	All
Ability to pay school fees	Education	Up to University	Up to University	Up to tertiary	Up to P7	None
	Frequency	Majority	Majority	Majority	Majority	All
Marital status	Type	Married	Married	Married	Married	Married
	Frequency	All	All	Majority	Majority	Majority
Money	Possession	Yes	Yes	Yes	Something	Do not have
	Frequency	All	All	All	Majority	All
Means of transport	Ownership	Car, bicycle, motor cycle	Car, bicycle, motor cycle	Bicycle	Have bicycles	Do not have
	Frequency	All	Majority	All	Majority	All
Crops grown	Type	Do not farm, traders	Several crops	Several crops	Subsistence	One type of crop
	Frequency	All	All	All	Majority	All

Wealth ranking by farmers generated a list of attributes which distinguished resource endowment, and grouped villagers into groups, and will later be used in interpreting soil fertility management decisions and needs. The indicators selected were farm/land size, livestock ownership, type of evidence so far is thin, FRGs may be less effective for research involving soil fertility and natural resource management, without short-term benefits to members.

- More than increasing the numbers of farmers and farmers' research groups, we need to invest in improving the quality of participation to achieve good quality research. This requires significant support and personal commitment of researchers. It also requires broadening the scope of PR from a functional consultative type to a more collegial empowering type, and from variety selection to broader natural resources management research.

Contributor: P. Sanginga (CIAT/PRGA).
Collaborators: AHI; CARE; Africare; NARO.

Impact of participatory methods to solve NRM conflicts: a stakeholder analysis

Rational: CIAT (IP-2 and PRGA) provides research and team backup to AHI sites in key social science issues around AHI strategy for community-based participatory approaches to solve natural resource management (NRM) problems. At the community and landscape levels, NRM is governed by complex, overlapping and sometimes conflicting social entitlements, objectives, interests, perceptions, knowledge and commitments of different resource users and stakeholders. Therefore NRM innovations should be geared towards strengthening mechanisms for stakeholder negotiation, conflict resolution and collective action and facilitating effective social organizations at the community level. The general hypothesis tested in this study is that facilitating stakeholders participation and negotiation of new resources sharing arrangements will improve natural resources management.

Methods: Field work has focused on action research in two micro watersheds in Rubaya within AHI's Kabale benchmark area of south-western Uganda, where resource sharing conflicts were identified as a main constraint to sustainable NRM. Methodology is based on the Hillsides Project stakeholder analysis for collective action, with an eclectic framework combining aspects of institutional analysis, stakeholder/gender analysis, network analysis, collective action and conflict management assessment to facilitate systematic data collection and analysis.

Results: Baseline studies have been completed on decision making at the household and community levels (i.e. who is making what type of decisions for what activity, how decisions are made in commonly managed resources), control and access of different types of resources, intra and inter-household gender relations, perceptions and awareness of NRM issues, resources sharing arrangements, NRM strategies, and knowledge and use of NRM technologies.

Stakeholder exercises identified, as the main local resident stakeholders groups, women and men; hillside farmers and valley bottom farmers; livestock owners; and local communities authorities (LC1 and LC2 chairmen). External stakeholders include valley bottom diary farmers ("big men"), a government wetlands program, and a range of supporting stakeholders (NGOs such as Africare, Water and Sanitation program, NARO). It was difficult to involve external non-resident stake-holders in the process of negotiation.

Maps were completed of local institutions and community organizations, and of resources sharing conflicts and arrangements. Core resources sharing issues included intra-, inter- and supra-household gender-related issues and conflicts (men and women, household versus community roles and needs); common property resources such as wetlands and grazing lands; hillsides management conflicts (destruction of terrace bunds); and crop raiding by animals. Local arrangements were identified for the management of livestock, labour, farm inputs and capital, and collective action. Current work now focuses on resources sharing arrangements, gender issues, and conflict management mechanisms on wetlands and terrace bunds.

NRM problems in Kabale are complex problems that require long-term and diversified interventions, and supportive institutions. The pressure for changes and sustainable NRM is recognized by farmers, but the incentives for collective action at the landscape level are not yet clearly understood by them. Collective management of hillsides (erosion control) is difficult and complex ginen these landscapes, land fragmentation and settlement patterns.

Seed multiplication and participation in crop variety evaluation were good entry points to sustain farmer participation. However, more entry-points and trade-offs need to be found in order to move on to more complex issues involving natural resource management conflicts, without the advantage of short-term benefits to farmers.

Group discussions with different categories of farmers and other stakeholders identified policies and bylaws as important aspects affecting different stakeholders and capable of catalyzing collective action. A proposal was developed this year to include the policy dimension, to add value to current efforts, on *"Strengthening social capital to improve policies and decision-making in NRM"*, and has attracted funding from DFID.

Contributor: P. Sanginga (CIAT/PRGA).
Collaborators: A. Stroud (ICRAF/AHI); AHI partners in Kabale.

Develop and apply participatory monitoring and evaluation in NRM

Rational: While there is widespread support for participatory research as a set of innovative approaches to NRM research and development, the issue of assessing its impact has become a concern. Since the impacts of PR are not often immediately visible in a short term, only systematic and continuous monitoring and evaluation will give valuable insights, and participatory monitoring and evaluation (PM&E) is an option for providing stakeholders with timely information about their activities. However, there is a paucity of practical guidelines and tools for monitoring and evaluation of participatory research processes in natural resources management.

Methods: Participatory monitoring and evaluation tools and methodologies for systematic learning and documentation of the participatory process from the perspectives of farmers and researchers are being developed and tested in the field at Kabale, and in regional workshops and site visits. Appropriate tools and experiences in applying process monitoring will be synthesised in a step by step PM&E Guide.

Results: Conceptual and empirical frameworks were developed for participatory monitoring and evaluation of the participatory research process from the perspectives of different stakeholders. The frameworks aim to map and track the process and changes, understand and explain the links between processes and outcomes (from context analysis, research design, inputs, intervention strategies, evolution, operations, achievements and difficulties) in a particular context. They involve recording and documenting observations on performance of PR (i.e. how well FPR is being implemented; what works and what doesn't work where, how and why; adjustments and refinements needed); and comparing them to intended objectives, outputs and outcomes.

Performance criteria and indicators were developed by farmers and farmers' research groups. Indicators were grouped into eight categories: activities, participation process, social and human capital, institutional effects, sustainability, technology outputs, dissemination and ultimate impacts. We are strengthening farmers' existing recording and monitoring systems, and capacity to monitor, evaluate, analyze and share data.

A step by step manual is being developed to assist PR practitioners to integrate PM&E into PR activities. The booklet is based on field experience in Kabale and other AHI sites, as well as current literature in the field of PM&E.

Contributor: P. Sanginga (CIAT/PRGA).
Collaborators: N. Lilja (CIAT/PRGA); J. Agunda (CARE Kenya); AHI and partners.

Activity 3.4 Inter-center and ecoregional linkages

Achievements:

- Most of the achievements outlined in Output 3 above, and some of those in Output 4 below, are directly related to our collaboration with the African Highlands Initiative, an ecoregional program of the CGIAR and a regional initiative of ASARECA [those achievements are not repeated in this section].

- Strategic links for IPM developed with ICIPE and IACR-Rothamsted for basic research and in-depth studies on bean pests.

New collaboration with international centers and advanced research institutions

Rationale: Basic research is needed to improve our understanding of interactions of insect and plant and hence our ability to plan appropriate management strategies, particularly for bean stem maggots, aphids and their natural enemies. Forging new partnerships with advanced research institutes offers an efficient method to do this.

Method: The Institute of Arable Crops Research (IACR - Rothamsted, UK) and the ICIPE have common interests in developing sustainable strategies for small scale farmers. We initiated informal collaboration, initially by electronic discussions, to pool our complementary strengths to address common objectives.

Results and discussion: A proposal was produced on the "*Development of a push-pull strategy utilising indigenous host and non-host plants to improve management of bean insect pests for smallholder farmers in Eastern Africa* ", in collaboration with NARS scientists. The proposal has passed initial screening by DFID and a project memorandum is under consideration. Under this arrangement, CIAT and participating network scientists will study interactions between the bean plant and its companion crops as they affect pest and natural enemy interactions, while ICIPE and IACR-Rothamsted will undertake studies to understand the chemical communication systems underlying these interactions. The research will contribute to IPM for bean pests.

Contributor: K. Ampofo
Collaborators: B. Torto (ICIPE); L. Wadhams (IACR-Rothamsted); ECABREN member countries.

Output 4. Technology adopted

Activity 4.1 Document local diffusion systems for technology and develop innovative seed systems

Achievements

- The number of requests for CIAT assistance in designing decentralized seed production interventions in Eastern and Southern Africa increased significantly.

- A framework for monitoring and evaluating decentralized seed production activities was developed.

- Two communities in Kampala, Uganda, took on the responsibility of developing a sustainable seed supply system for urban bean farmers, and explored techniques for staking climbing beans.

Developing sustainable decentralized seed production systems in Africa

Rationale: Beans, like other self-pollinating crops, bring little profit to seed companies for several reasons: uncertain and fluctuating demand caused by competition from farm-saved seed, a low multiplication rate and, in many cases, strong regionally specific preferences. CIAT promotes decentralized seed production as a sustainable approach to accelerating adoption of modern crop varieties.

Methods: Moving beyond the action research phase, CIAT's strategy focuses on the development of training materials and offering advisory services to researchers and NGOs on project design and implementation.

Results and discussion:
African Highlands Initiative: CIAT's social scientist supported seed production activities by AHI by facilitating planning workshops for three more sites in 1999-2000. The objective of workshops in Kabale (Uganda), Lushoto (Tanzania) and Antsirabe (Madagascar) were to design and launch decentralized seed production and dissemination, including the catalyzing of cross-commodity activities. By producing rapid and more cost-effective impact than can be achieved by a commodity program working alone, AHI teams assist communities in food security and income generation that can sustain their commitment to the more difficult and longer-term NRM activities.

AHI has probably been too optimistic in expecting regional commodity networks (including ECABREN) to voluntarily pick up the implementation of sites' seed plans, which do not necessarily represent priority locations or activities for those networks. Nor do clear mechanisms yet exist for networks to plan and implement together, even when this may improve their overall cost-effectiveness. Nevertheless, ASARECA has encouraged its commodity networks to do this, and may wish to consider more explicit policy advice to achieve this.

Other initiatives:

Reflecting the growing interest in alternative seed provision systems and a recognition of CIAT's expertise in this area, there has been a significant increase in the number of requests for CIAT's assistance in the area of seed supply (Table 32).

Structures established in Malawi to promote small-scale farmer seed production provide a model for institutionalising decentralized seed production. Since 1996, a European Union and Government of Malawi project selected and organized farmers to produce certified seed of open-pollinated variety (OPV) maize, groundnuts, soybeans and beans commercially. Individual farmer seed producers are organized into Seed Marketing Action Groups (SMAGs) to facilitate input supply, marketing, training and processing. Several SMAGs form an association, and there are presently 8 associations. Associations are coordinated by an umbrella organization, the National Smallholder Seed Producers Association (NASSPA), which aims to address demand from neighboring countries also.

In the 1999/2000 season, 186 farmers sowed 6.1 tons of four bean varieties released by the Malawi Bean Program; estimated production was 87 tons. By contrast, 1670 farmers sowed groundnut seed. Several factors are responsible for low interest in bean production by farmer seed producers and low production. These include: poorer prices for beans than for maize and groundnuts (to some extent an artificial situation created by large-scale seed distribution projects) and the high cost and unavailability of foundation seed.

Table 32. Requests to CIAT for assistance on decentralized seed production, 1999-2000.

Institution	Type of assistance requested
NARO, Uganda	Develop proposal for farmer seed production near new agricultural research & development centers (ARDCs)
CARE International, Uganda	Advise on initiating farmer seed production
Bean Improvement Program, Malawi	Review existing seed supply for beans and advise on a sustainable strategy to promote bean seed production
AHI	Develop a monitoring and evaluation framework for decentralized seed production activities
AHI	Advise on methodology for evaluating farmer seed potato production in Kabale, Uganda
EU Food Security and Food Aid Program, Malawi	Translate bean seed production manual into Chichewa and Tumbuku languages for use by NSSPA and others
ActionAid, Malawi	Advise on developing a project on small-scale commercial seed production
Uganda Rural Development Training Program (URDT)	Advise on seed production strategy and develop proposal to VOCA for a seed specialist consultant
FOFIFA	Translate seed production manual into Malgash language
PRGA	Organize and facilitate a mini-workshop on farmer involvement in seed production (part of international PRGA workshop)

Although it is too early to assess the extent to which NASSPA will be geared toward meeting small farmers' bean seed requirements while maintaining its status as a viable business enterprise with strong regional connections, there are two possible concerns. One danger is that NASSPA might turn most of its attention to regional markets at the expense of addressing local demand. The second concern is the emphasis on certified bean seed production, which may push prices beyond a level affordable by most small farmers. These two issues justify establishing smaller farmer seed enterprises (i.e. micro enterprises) to produce commercially non-certified seed on a small scale for local sale. Micro farmer seed enterprises would be linked to the NASSPA system for sourcing certified seed. ActionAid Malawi is developing a proposal to support the development of micro farmer seed enterprises with input from CIAT.

Contributor: S. David
Collaborator: R. Chirwa

A monitoring and evaluation framework for decentralized seed production interventions

Rationale: Developing the capacity of farmers and local institutions (e.g. schools and churches) to produce seed is a part of process oriented research that needs to be carefully documented in order to improve learning and encourage scaling-up.

Discussion: The framework for monitoring and evaluating decentralized seed production interventions targets a diversity of institutions (AHI, projects, NGOs, IARCs, donors) (Table 33). Checklists were also developed covering 10 major M&E areas. This framework will be tested in 2 AHI sites (Kakamega and Lushoto).

Table 33. Indicators for monitoring and evaluating decentralized seed production interventions.

M&E objectives	Target institutions	Key indicators
Basic internal monitoring of activities and processes	AHI sites	Information on producers Seasonal seed production Seed marketed Number of buyers Price of seed Inter-institutional collaboration Farmer empowerment
Detailed internal monitoring of activities and processes	Seed production projects, AHI	All of the above plus -- Seed quality/health -- Sustainability -- Organizational issues -- Economics of production
Monitoring for research and development of guidelines for scaling up	CIAT, other IARCs, NARS, donors	All of the above plus -- Changes in producers' awareness/knowledge of seed health/quality -- Policy changes -- Training issues
Impact assessment	All, donors, ASARECA	Impact of seed production on the producers Impact of seed production on community/local area Adoption of materials supplied by DSP activity

Contributors: S. David; C. Opondo (ICRAF/AHI)

Promotion and dissemination of bush and climbing beans among urban farmers

Rationale: Given the shortage of land available to urban African farmers and their motive to improve household food supply, new bean varieties, and especially climbing beans, potentially offer an important advantage by producing higher yields. However, different approaches may be necessary for successful promotion and seed distribution efforts in an urban setting. Moreover, climbing bean production may face specific constraints in towns due to land tenure issues (insecurity), theft and shortage of staking materials. Lessons learned in Kampala, Uganda, are likely to be widely applicable in other East African cities.

Methods: In 1999b and 2000a seasons, seed of four bush bean varieties and two climbing bean varieties were delivered to local authorities in two Kampala communities: Kansanga Parish (Makindye Division) and Naguru 1 and 2 Parishes (Nakawa Division). This activity was a continuation of a seed dissemination project initiated in 1999a. In September 2000, group meetings were held with farmers who grew the new varieties to obtain feed back, address constraints and explore ideas for future activities.

Results and discussion:
Impact: Modern bush and climbing bean varieties were positively received by urban farmers in Kampala. Initial impressions of adoption from group meetings (Table 34) show that K 132 (Calima type) and MCM 2001 (small red type) were the most appreciated varieties. In evaluating the new varieties, urban farmers mentioned similar desired characteristics as rural farmers: yield, taste (of both grain and leaves), red color, early maturity, quick cooking time and resistance to drought, diseases and pests. However, compared to rural farmers, marketability is of lower priority to the majority of urban farmers, who mainly grow beans for household consumption. Farmers reported that the introduced varieties had increased food supply and reduced spending on cooking fuel.

Solving the staking and seed supply problem: Although farmers appreciated the higher yields of climbing beans, a new technology to most, the single most important constraint was the shortage of staking materials. Other constraints to the adoption of climbers, especially in Nakawa, were low soil fertility and unseasonably low rainfall. Farmers had tried a number of materials as stakes including cassava sticks, reeds, maize, banana plants and string tied to walls. Farmers came up with new ideas for staking and say they will experiment next year with new staking methods, namely, strings tied to poles and walls, and cassava and banana plants as live stakes. To ensure sustainability, the responsibility of supplying seed of new varieties was turned over to the communities. It was agreed that local leaders would purchase seed for sale to interested farmers.

Table 34. Uptake of introduced bush and climbing bean varieties by Kampala farmers who attended a group meeting (number of observations).

	No. of farmers who ever sowed		No. of farmers who sowed in 2000a	
	Kansanga (N=17)	Nakawa (N=5)	Kansanga (N=17)	Nakawa (N=5)
K132	15	5	15	5
K131	14	2	5	1
MCM 1015	10	2	3	1
MCM 2001	17	4	9	1
Climbing beans	18	2	9	0

Contributors: S. David; G. Luyima and M. Ugen (NARO)

Activity 4.2 Promotion of crop and pest management options

Achievements:

- IPM was successfully disseminated in a pilot trial through a decentralized and participatory approach.
- Participatory extension helped farmers to understand complex crop and pest problems and decide on management strategies, and caused them to want to tell others about what they learned in research groups.
- Farmers are interested to contribute their own treatments and experiment with indigenous technical knowledge. Locally available botanicals proved to be effective in protecting grains in storage.

Scaling up IPM for bean foliage beetle with partners in northern Tanzania

Rationale: IPM strategies for bean pests have been developed by CIAT and the Bean Networks at pilot sites, but scaling up to other areas has been slow. National extension systems need strengthening to disseminate IPM strategies more widely to farmers, and an appropriate role for CIAT is to support the development of pilot case studies.

Method: This year we initiated work to develop IPM scaling up strategies against *Ootheca*, the bean foliage beetle (BFB) among small-scale bean growers in Hai District, northern Tanzania, in collaboration the district extension office. In a stakeholders meeting, the management strategies were reviewed and dissemination pathways discussed. Each village group (farmers and the local extension officer) considered their resources and opportunities, and identified dissemination pathways that suited their circumstances. The popularity of pathways selected by different villages, in rank order, were: 1. on-farm demonstrations; 2. demonstrations in schools; 3. training through farmer research groups; 4. distribution of extension information leaflets about the problem and its management; and 5. awareness-creating seminars and field tours.

Each group discussed the pest and the available options for management with their respective village farmer' research group (FRG), who modified or added to them as they found necessary. FRGs implemented the demonstrations with the assistance of the local village extension officer. We monitored farmers' perception of the IPM strategies and the promotion process employed, using questionnaire surveys during field days.

Results and discussion: IPM strategies selected at the stakeholders meeting were: 1. delay planting time of beans to avoid peaks of BFB infestation; and 2. application of neem seed oil and neem seed powder as botanical pesticides. Farmers added traditional technologies, such as: fermented cow urine (*mkojo*); fermented liquid effluent from the cow shed (a mixture of urine and faeces known as *mfori*); kerosene and soap mixed with water; and ashes. These treatments were compared in the participatory demonstrations (Figure 14). The selected dissemination strategies were: seminars and distribution of extension leaflets to create awareness about the pest, and field demonstrations of the management strategies. The dissemination centers were schools, community training centers and farms at vantage locations within the villages.

All treatments worked better that the control. The effect of cow urine lasted longer, and most delayed re-infestation (Figure 14). To publicize the technologies further, the FRGs held a series of field days and invited the local communities to view and discuss the demonstrations. Ashes, neem oil and fermented cow urine were the most preferred treatments for BFB control by participants at the field days (Figure 15). In reviewing future dissemination approaches, the communities preferred: 1. more seminars for awareness creation; 2. improving effectiveness and empowering the extension system; and 3. dissemination through the mass media to reach more farmers. Non-participating farmers were strongly in favor of more demonstrations, while FRG members were favored dissemination through mass media and distribution of extension leaflets (Figure 16). Also, the large farmers (> 0.4 ha of beans) selected group training as their preferred option for IPM dissemination, while small farmers preferred demonstrations (Figure 17). It appeared from further discussion that small farmers had less time for regular group activities, as they can make limited use of external labor and therefore are fully occupied by farm and other activities.

The selection of different dissemination pathways by large and small farmers suggests that these groups should be targeted with different approaches. In a post-season monitoring and evaluation exercise, farmers also cautioned that multiple strategies should be used as different strategies target different categories of farmers. There is now increased demand for IPM promotion to reach more farmers. The extension service plans to develop mass media (radio and newspaper) messages on BFB management for a wider audience. We are also seeking funds to enable partners to disseminate bean pest IPM more widely across eastern and southern Africa.

Contributors: K. Ampofo, U. Hollenweger.
Collaborators: Edward Uliky (DALDO, Hai District) C. Sirito (SARI, Arusha)

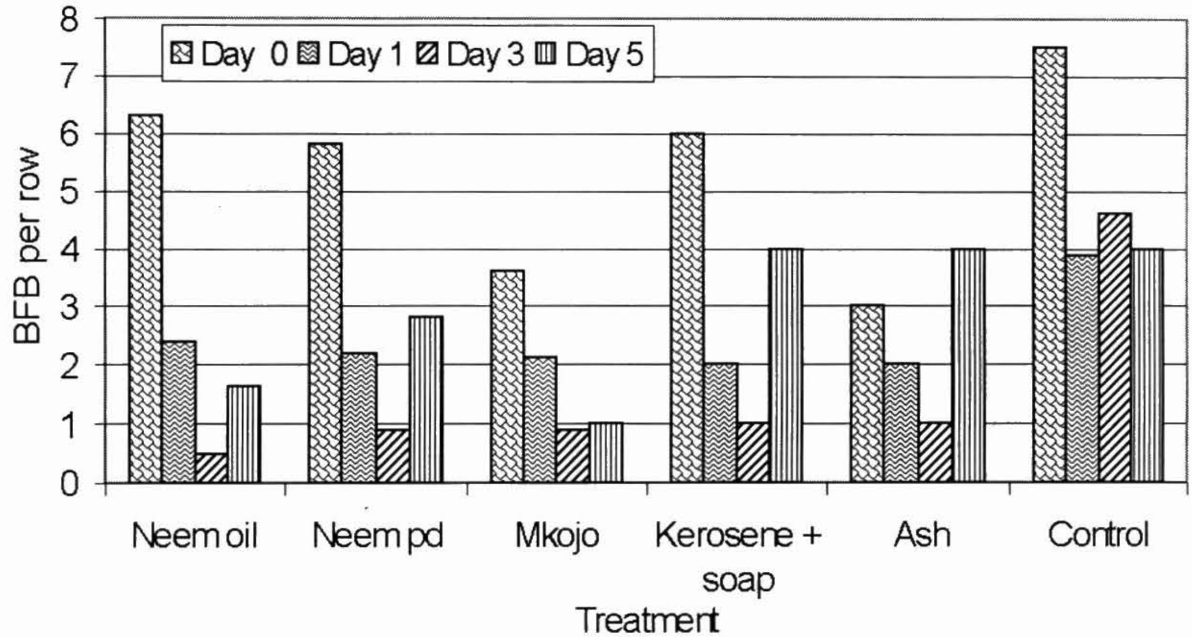


Figure 14. Performance of neem and other traditional products against bean foliage beetle in farmers' fields at Hai, Tanzania.

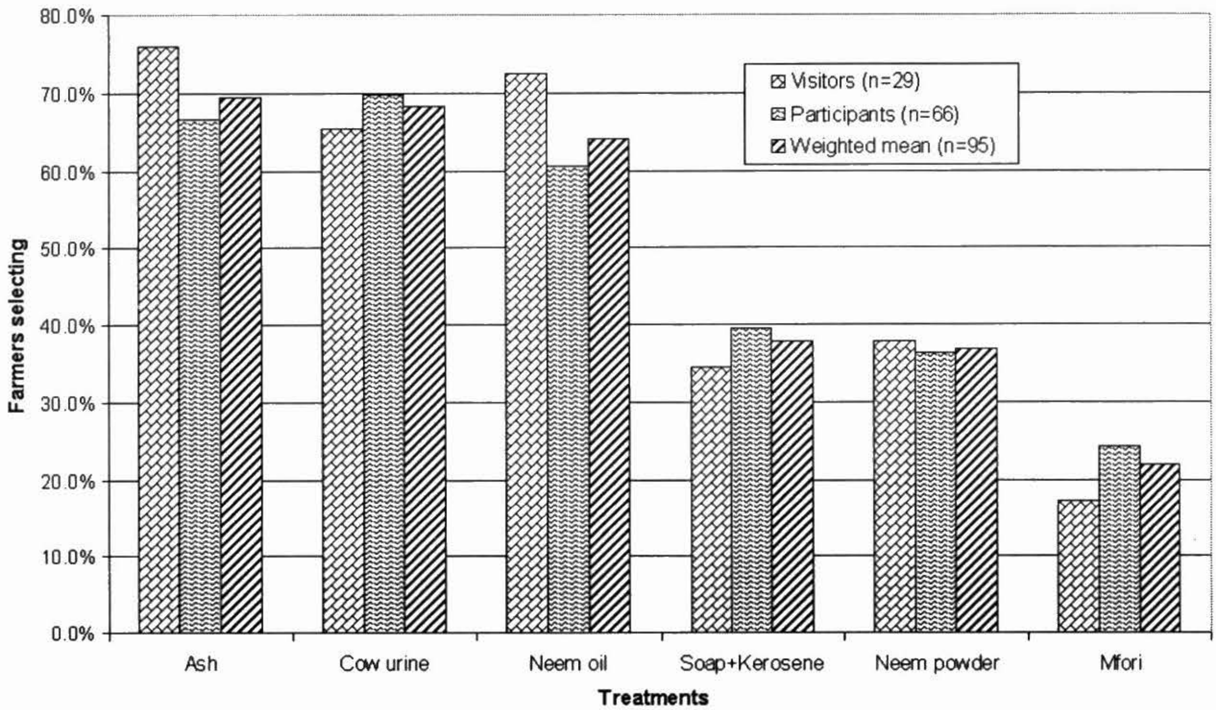


Figure 15. Preferences of FRG members and non-members for BFB management strategies.

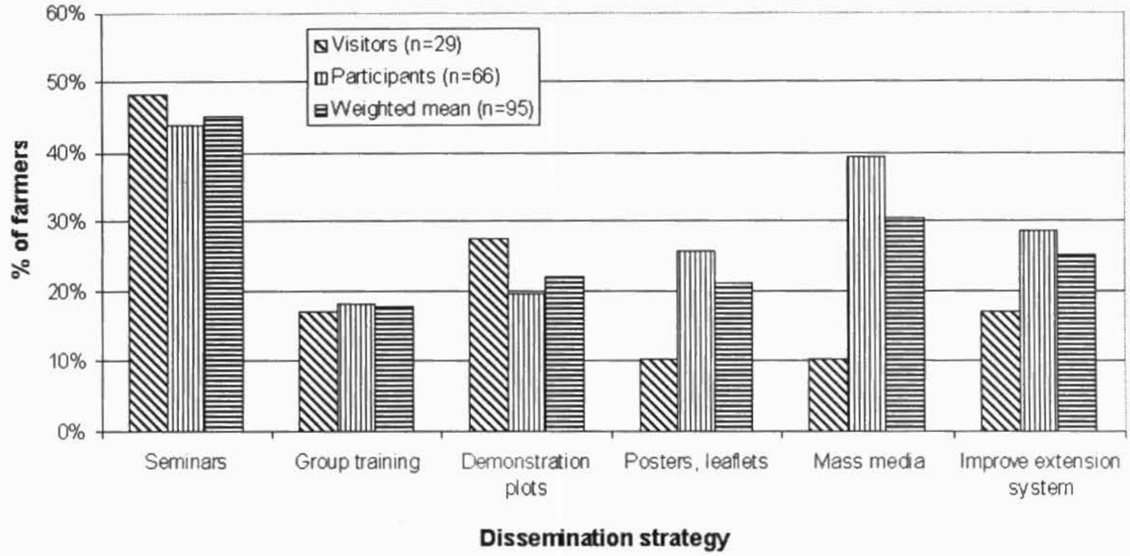
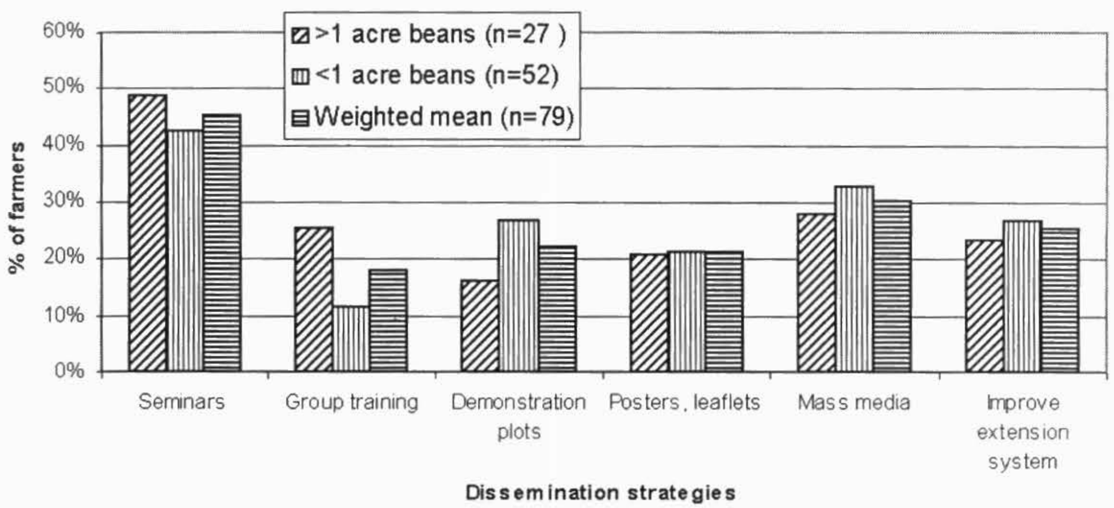


Figure 16. Selection of IPM dissemination channels by FRG members and non-members at Hai, Tanzania.Figure



17. **Selection of IPM dissemination channels by large and small farmers at Hai, Tanzania.**

Approaches for improved dissemination: action research in Arumeru, Tanzania

Rationale: Disseminating agricultural technologies is more likely to be effective if based on farmers' ways of learning about new ideas and how they pass on innovations to other farmers. This action research project seeks to put theory into practice by working in close collaboration with farmers on some of their problems. It also monitors the dissemination of several technologies that are developed or adapted together. The outputs are ideas and approaches for enhancing dissemination, adoption and impact.

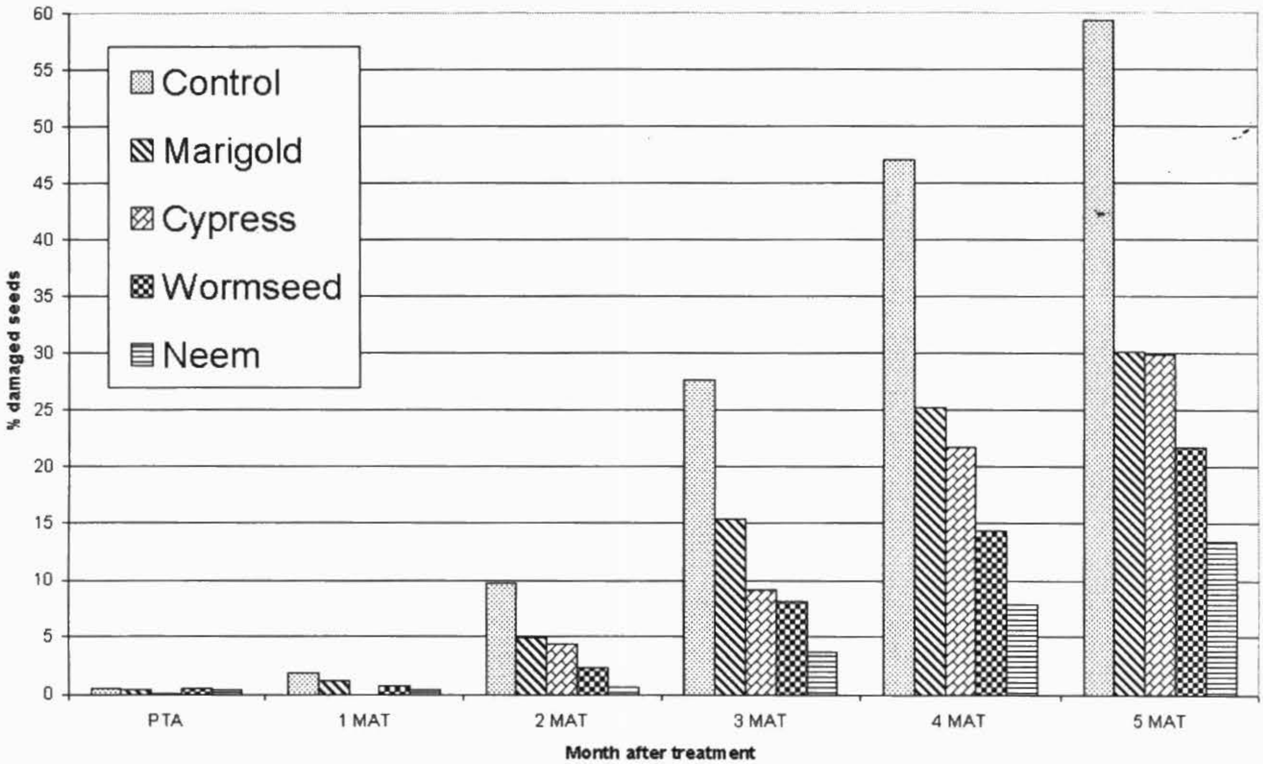
General methods: During this second phase, different technologies were tested in 6 villages in three agroecological zones of Arumeru District, Northern Tanzania. Each village was encouraged to decide on the research problem, and the research plan was elaborated together. The resulting small trials included storage problems, bean and maize varieties, wheat and safflower production, pest management in beans and soil borne problems. Methods used ranged from field trials to demonstration plots and observations in farmers' fields. Most trials were farmer planned, implemented and managed.

Results:

Storage of bean and maize using locally available botanicals

In close collaboration with TPRI researchers, four farmers were selected in each of 7 villages. Each farmer contributed either 60 kg of beans or maize for a trial with the following locally available botanical treatments: dried marigold (*Tagetes minuta*) or cypress leaves (*Cupressus sp.*) at 1.5 kg/100 kg, dried wormseed (*Chenopodium sp.*) at 1kg/100 kg and neem seed powder (*Azadirachta indica*) at 1.5kg/100 kg, and an untreated control. Grain was packed in 5 kg bags and stored by farmers as usually done; contact was prevented. Samples were taken before treatment and monthly during 5 months for beans and 4 months for maize. Grain damage, live/moribund/dead insects and seed viability were assessed, and farmers were asked to evaluate the treatments.

Neem was the best treatment; and wormseed (*Chenopodium sp.*) gave slightly better protection than cypress and marigold. All treatments were better than the control. Neem reduced damage over a longer period: after 4 months damage was still below 10%. It was followed by wormseed (3 months below 10% damage and 4 months below 15%). Cypress protected well for 3 months (damage below 10 %), but damage after 4 months was above 20%. Marigold was the weakest treatment (after 3 months at ~15% damage). While wormseed, cypress and marigold repel the insects, neem has some repellant effect but also kills insects. Germination was not influenced by the botanicals, but was reduced in the heavily damaged samples. Farmers liked all treatments to varying extents, but said that the strong smell of wormseed made maize unsuitable for human consumption. Neem was not readily available in most villages and wormseed was not available in large quantities but could be planted easily (Figures 18 to 20).



PTA = pre treatment assessment; 1 to 5 MAT = months after treatment.

Figure 18: Grain damage over 5 months.

Promotion of IPM strategies

In four villages farmers expressed a wish to learn better bean crop management. As the rains started late, we assumed that bean stem maggot (BSM, *Ophiomyia spp.*) might become an important problem and planned accordingly with the farmers. We explained the pest and its lifecycle, and farmers recognised the insect as a problem in their villages. They selected improved varieties and seed dressing for testing management strategies, and we added fertilizer and manure as two more components.

In villages where the crop was planted independently of our visits, some treatment errors occurred. In two villages where we planted the trial together, seed dressing, fertilizer and pesticide proved to be effective against BSM (Figure 21). The fieldwork carries out with farmers included observations on plant vigor, pest incidence, the lifecycle of BSM, and plant mortality due to BSM, root-rot and other causes.

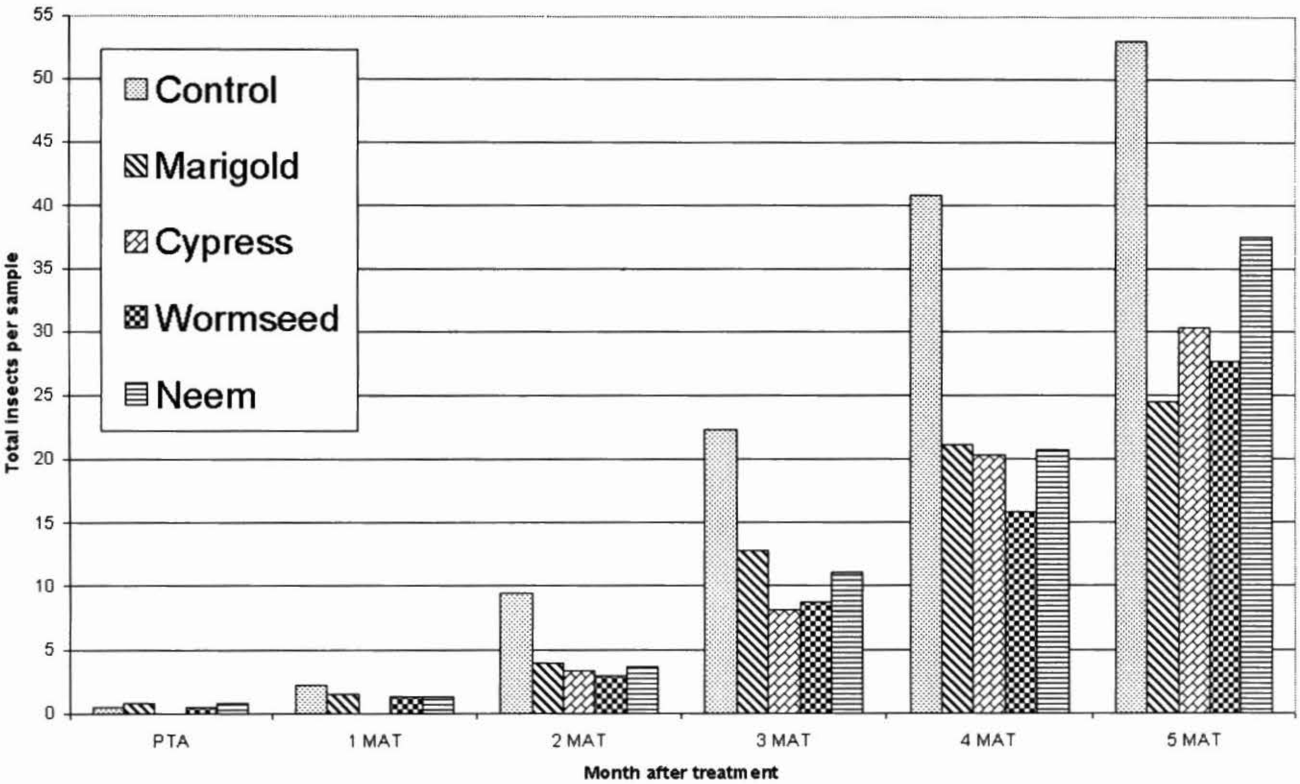


Figure 19. Total insects per sample over 5 months.

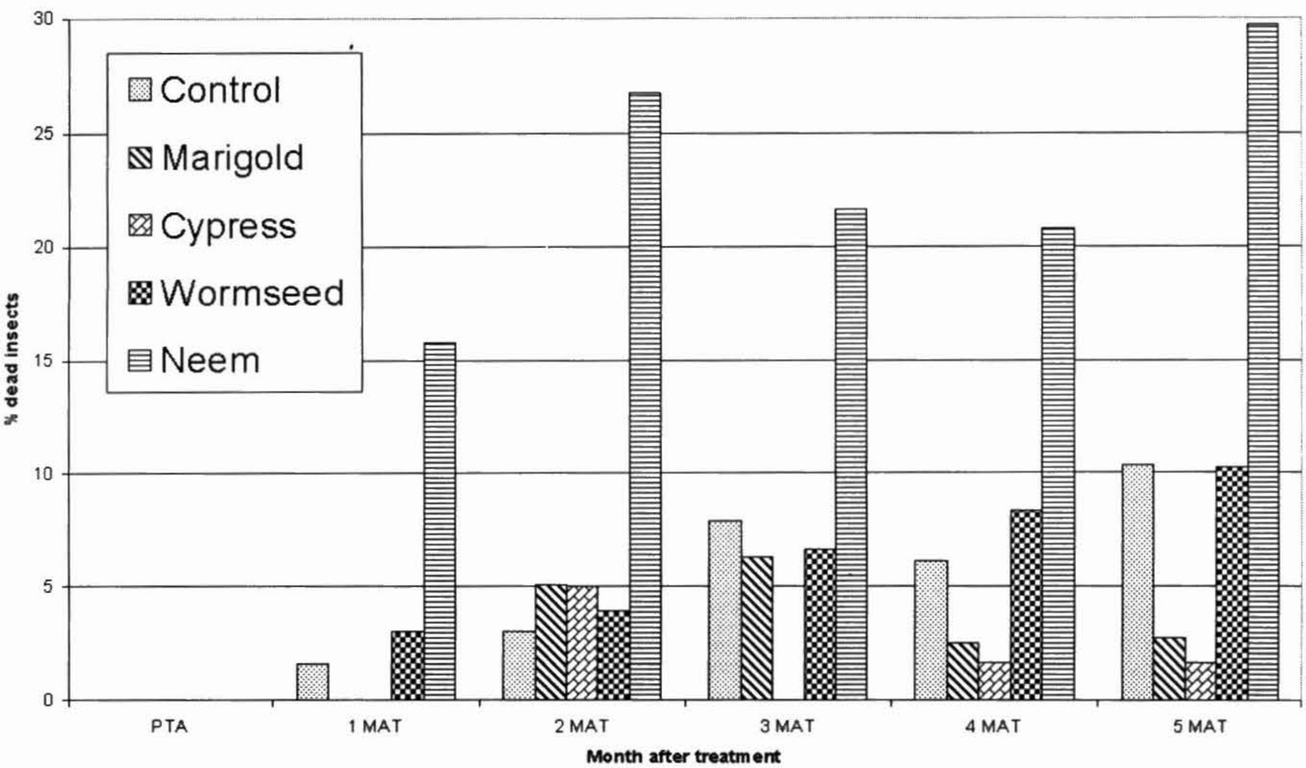


Figure 20. Percent dead insects.

When aphids became a problem at Kikatiti, farmers were eager to try local treatments they learned during a field day in Hai District against bean foliar beetle (*Ootheca spp.*) (see above, *Scaling up IPM...*). We divided a bean plot with the same three varieties into six parts and appliedfive treatments (cow urine, neem seed powder, combined manure and urine (*mfori*), kerosene and soap, tobacco with hot peppers). As the infestation was very heavy and the plants suffered water stress, the field activity did not give good results. A few farmers were then invited to the research station and we tried the treatments on greenhouse plants, by spraying the concoction on plants in 6 pots or sprinkling with local grass brooms. The next day we evaluated the plants together. Manure/urine and kerosene/ soap mixtures burned some plants, neem seed powder was not effective (the seed was from last year) and tobacco with hot pepper resulted in high aphid mortality. We discussed the results with farmers and they suggested how to continue the research (see Table 35).

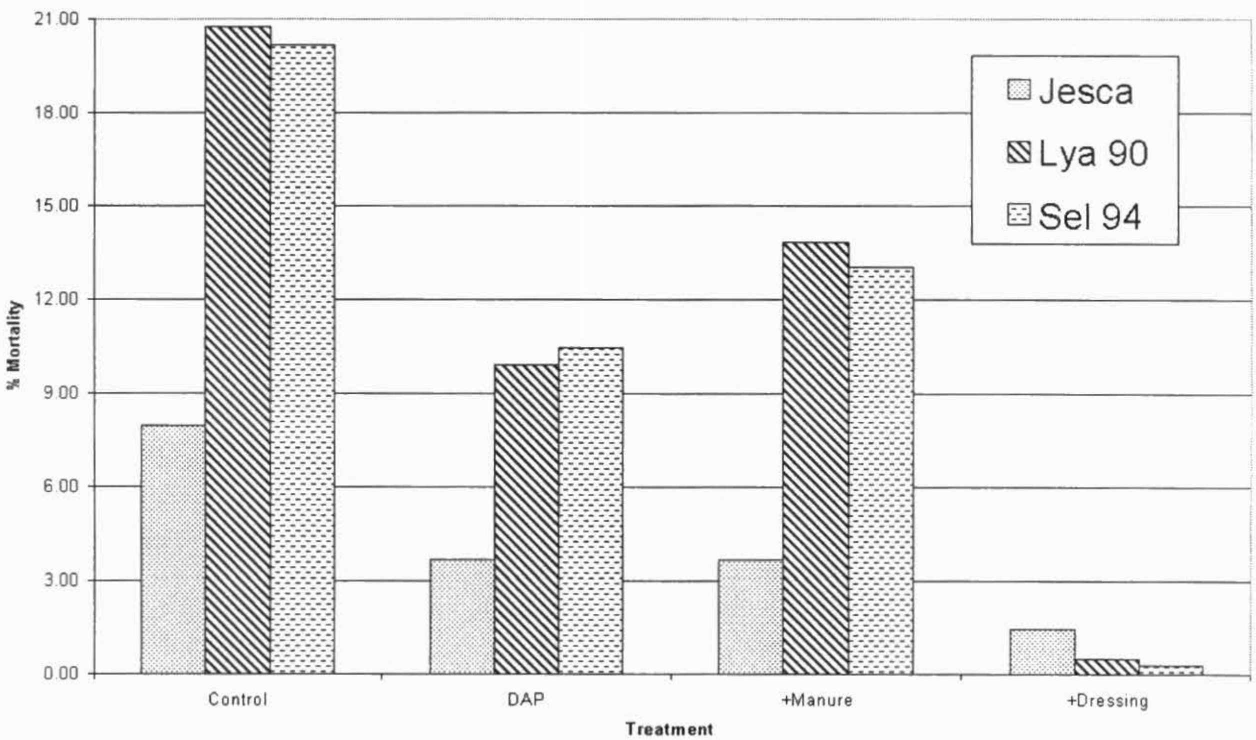


Figure 21. Plant mortality due to stem maggot in three bean varieties (percent over 3 sites).

Table 35. Participatory evaluation of local treatments against aphids.

Treatment	Aphid mortality	Treatment disadvantages	Farmer suggestions
Water	90% (broom application – mechanical effect or pesticide drift?); < 20% (by sprayer).	•	none
Manure/ urine	10 % only	Plants were burned; difficult to sieve material for sprayer application	Experiment on mixtures, concentration and fermentation
Neem seed powder	About 20 % only	Local seed from last year might have "expired"	Experiment on concentration and preparation
Tobacco/ hot pepper	About 70% (broom) to 100% (sprayer)	Burns on skin	Experimentation on concentration and other mixtures
Kerosene and soap	99-100%	Can burn plants; kerosene destroys diaphragm of sprayer	Experiment on concentration; calculate use per acre

Evaluation of climbing beans:

Another intensification strategy of interest to farmers was testing new bean varieties. We invited two groups of farmers to the research station in 1999 to learn about climbing beans as a potential innovation; they requested seed to try in their respective environments. Each village selected 6 farmers, who received 100g of 6 varieties. It was left to them to plant and manage, although they could approach us for advice during our visits. After harvest, we measured yields and discussed farmers' evaluation.

Because of the drought, four farmers have not yet planted; several others lost seed (due to drought, fire or damage by livestock); and two farmers lost almost all due to root rot. The results so far available (Table 36) give only an indication of yield. Farmers' ranking criteria were yield, color (marketability), taste and days to maturity. The difference in ranking reflects preference differences between farmers, who intend to continue the test. They anticipated that staking would be difficult on much larger plots. Both farmers cooked some of the beans, but kept most for replanting and to respond to requests from friends and relatives.

In many places the new bush bean variety Jesca was highly appreciated for its early maturity and drought tolerance. An unexpected side observation was that manganese and iron toxicity (locally called Problem Y) appeared to be especially acute on this variety.

Table 36. Six Climbing bean varieties evaluated by two farmers in Arumeru.

Variety	Type and color	Seed yield (g) from 100 g seed		Farmer's ranking	
		Farmer 1	Farmer 2	Farmer 1	Farmer 2
R7	Mwezi moja, purple	1,640	1,340	1	6
R26	Kidney, dark red/purple	1,750	1,515	4	4
R27	Maasai Red, light red	2,700	3,400	3	3
R129	Pinto, cream/beige	1,620	1,620	6	5
R143	Rose Coco, round, red	1,120	2,080	5	1
IZO 201518	Kablanketi (Mwezi moja), round, purple	1,460	1,930	2	2

General discussion: Due to failed rains most trials performed poorly, some failed to yield at all, and data collection was seriously affected. Nevertheless, most farmers appeared undeterred by the trial crop failures, appreciated the learning process, and want to continue the collaboration with research. Four villages asked for more trials in the coming season, hoping for better conditions.

Some went further. Some farmers felt comfortable taking the lessons learned to farmer research groups in adjoining villages, and field days were helpful in enabling farmers to share their experience with other communities. One farmer group decided to work on extension material to help them to talk to their fellow farmers about the lessons learned — farmers developed a first draft of a leaflet on BSM management, we typed it and the farmers are reviewing it. Another group started multiplying the new varieties for wider dissemination in their village; and a third group called village meetings at which we are invited to teach. Involving an NGO (Kakute) which demonstrated water pumps, oil press and fuel-efficient cooking stoves provided added incentive for farmers, as the NGO has started to buy *Jatropha* seed from the farmers for soap making.

Contributor: U. Hollenweger
Collaborators: K. Ampofo, D. Mohamed; R. Ndondi, Mrs. Ngulu, Z. Mduruma and P. Ndakidemi (SARI); J. A. Saidi Lossini and Mariam Njama (TPRI); A. Mushi (FAIDA); Magdalena Ayoo (Kakute).

Activity 4.3 Develop improved methods for documenting social and environmental impacts

No significant outputs in this area this year.

Activity 4.4 Adoption and impact of bean research

Achievements:

- Despite a massive effort to distribute K131 (a new seed type) in Luuka County, Uganda, there was insignificant adoption due to the promotion of the variety as a cash crop and marketing difficulties experienced by farmers
- Market surveys in Northern Tanzania showed that Lyamungu varieties, widely disseminated 10 years ago, gained 2nd and 4th places in Kilimanjaro and Arusha Regions in market share

Factors affecting the adoption of a new and non-preferred bean seed type

Rationale: Farmers in many parts of Eastern Africa prefer large seeded bean varieties for culinary, aesthetic and market related reasons. Yet, small seeded varieties have a higher yield potential, and successful strategies for the effective promotion and dissemination of new and non-preferred seed types would increase productivity. In addition, researchers need to better understand the adoption pattern of new, non-preferred bean varieties.

Methods: In 1996 the USAID-sponsored Agribusiness Development Center (ADC) supplied 22 tons of K131, a small seeded Carioca variety released in 1994, to 250 womens groups in Luuka County, Iganga District in Eastern Uganda. Approximately 4,100 farming households received 5 kg of K131 free of charge, with the agreement that they would return a portion of their harvest to ADC for further redistribution. ADC provided free extension services to ensure that farmers followed recommended agronomic practices including line planting. The project also arranged for a local trading company to purchase the variety from farmers, as K131 has low market demand because of its seed type.

In the second season of 1998, a formal survey was conducted by an MSc student from the Department of Agricultural Economics, Makerere University, to assess the extent of adoption of K131 and to investigate factors affecting this process. The study drew two samples of farmers from two villages: seed recipients (n=60) and a randomly selected sample of farmers (n=30).

Results and discussion: Most seed recipients (67%) continued to grow K131 three years (six seasons) after it was first introduced to the area. However, farmers sowed only small areas to the new variety (an average of 0.06 ha) and production trends showed that mean amounts sown had declined from 5 kg in the first season of 1996 to 2 kg in the second season of 1998. Major reasons for declining production and disadoption included lack of market, problems in retaining seed (farmers either ate the seed or lost it during periods of drought) and line planting as enforced by extension agents. The trading company identified by ADC absconded from its commitment to buy K131 and farmers were unable to find an alternative market.

This experience shows the danger of promoting locally-unknown bean seed types as cash crops, especially where there is poor follow-up of marketing arrangements. The findings suggest that, in addition to low market demand, seed supply was an important constraint to adoption. If a system existed to supply seed on a continuous basis and K 131 had been promoted as a variety to meet food security needs, adoption might have been higher.

Contributors: E. Kato (Makerere); S. David.

Adoption of modern bean varieties in Northern Tanzania: results from market surveys

Rationale: Household surveys to assess the adoption of modern bean varieties are prohibitively expensive and time consuming. Market surveys designed to estimate the marketed surplus of new bean cultivars in key regional markets could supplement household surveys or, on their own, provide an indication of the adoption rate of marketed seed types.

Methods: Surveys of markets in Arusha (N=8) and Kilimanjaro (N=6) Regions were conducted in August 1997. Purposively selected traders (N=74) were interviewed to determine the bean varieties they sold and estimate the market share of three modern varieties: Lyamungu 85/90 and Selian 94. Thirty-nine farmers and 38 consumers were also interviewed. An important methodological issue to point out was the inability of some respondents in all categories to distinguish the Lyamungu varieties from older Calima varieties (Rosecoco, Nyayo).

Results and discussion:

Traders: The most commonly sold bean varieties were Bwana Shamba (69% of traders in Arusha Region) and Soya (Kablanketi) (83% of traders in Kilimanjaro Region). Other prominent varieties were Masai Red and Karanga in Arusha Region and Lyamungu 85/90 and Ingichumba Nyeupe in Kilimanjaro Region. The Lyamungu varieties were 4th and 2nd in terms of estimated market share (Table 37). Female traders, who generally deal with smaller volumes compared to male traders, were more likely to sell the new varieties. Because of the importance of cross-border trade, there is need to investigate the presence of the new varieties in Kenyan and Ugandan markets. Most traders in Arusha Region started to sell the Lyamungu varieties after 1996, while traders in Kilimanjaro had longer experience in selling them. Traders learn about new bean varieties from other traders and from farmers, and take an average of two years to include a new variety in their stock after first hearing about it.

Farmers: About half of the farmers surveyed had sown one of the three new bean varieties (Table 38). Slightly more farmers in Arusha Region had experience with them. The main sources of seed for all three varieties were markets, followed by other farmers. At all times of the year, farm gate prices for the Lyamungu varieties were higher on average than other bean varieties: Tsh. 578/kg at planting time and Tsh 260/kg at harvest compared to Tsh 444/kg and Tsh 205/kg.

Consumers: The most common bean varieties purchased by consumers in both regions were Soya, Bwana shamba and Karanga. The new Lyamungu varieties were only purchased by three consumers in Arusha region. The majority of respondents (62%) always purchase the same variety. The Lyamungu varieties were appreciated for their taste, color and quick cooking time. Most consumers purchased the concerned varieties shortly after they first saw them, suggesting that the time lag often observed between the release of a new seed type and uptake by consumers is attributable to traders. Informal market observations made since this study in 1997 indicate that the popularity and prevalence of the Lyamungu varieties have continued to escalate.

Table 37. Market share of bean varieties sold in Tanzanian markets by region (%), August 1997.

Variety	Arusha	Kilimanjaro
Bwana shamba	64	9
Masai red	22	10
Soya	6	49
Lyamungu 85/90 [new]	4	14
Karanga	3	8
Combat	2	5
Ingichumba Nyeupe	0.1	6

Table 38. Percent of farmers in N. Tanzania who had sown a modern bean variety, August 1997.

	Arusha	Kilimanjaro
Lyamungu 85	52	50
Lyamungu 90	56	46
Selian 94	46	39

Contributor: M. Kamau (KARI, now with Tegemeo Institute)

Activity 4.5 Propose policy reforms that facilitate technology adoption

Achievements:

- Presenting the evidence of bean impact, achieved through improving farmers' access to a wide range of cultivar types and strengthening decentralised farmer-based seed systems, helped East African institutions reach sensitive decisions on desirable seed policies that would benefit farmers of different kinds.

- A study of the effectiveness of seed aid after drought in Kenya showed that, for their main crops of maize and beans, small farmers routinely rely on local markets for a significant proportion of their seed, due to their declining capacity to produce a sufficient quantity.

- Seed aid generally treats a symptom, and perhaps not in the most effective way. Those who received seed aid once were not necessarily less likely to receive it again: amounts given were not significant in the context of farmers' overall seed procurement strategies.

- In semi-arid areas, farmers chronically short of their own home-saved seed and chronically sort of cash to top off stocks with market purchases might be better off with open pollinated varieties or vegetatively propagated crops. Chronic stress also demands a more holistic seed system support approach, beyond issues of seed and variety.

Contributions to development of harmonized seed policies in Eastern Africa

Rationale: Seed policies are set by individual countries, where they have been developed independently and in response to varying concerns at different times; some are deterrents to innovation, others appear outdated and/or do not foster regional collaboration. CIAT and the bean networks have much experience to offer the region with regard to what works with self-pollinated food crops in which the private seed sector has limited commercial interest.

Method: We contributed experiences and evidence to a study and several meetings, coordinated by the Eastern and Central Africa Policy and Planning Network (ECAPAPA) of ASARECA, aimed at reaching regional agreement to harmonize a logical and streamlined set of national seed policies.

Results and discussion: Initial opinion in the region appeared to be that the Western 'maize experience' with full certification and private sector seed companies would resolve seed dissemination constraints for most crops and remove the need to develop small farmer seed enterprises – indeed, that supporting the latter could delay the emergence of the former.

Presenting the evidence of impact from bean breeding achieved through decentralised farmer-based seed systems, and on the unnecessary cost and uncompetitiveness of self-pollinated seed if produced to very high commercial quality standards, helped the study reach a moderate final consensus. Decentralised farmer seed enterprises will continue to be allowed in East Africa, but should be linked whenever possible to private sector production of basic seed.

Four seed classes were accepted across the three countries - - breeders, basic, certified and standard seed. The workshop agreed on laboratory standards appropriate for each class of seed for five crops, a measure that should also favor farmer seed enterprises while imposing some quality norms.

Variety evaluation, release and registration was another issue where a range of views existed. Support for the development of a strong private seed sector in the region could have resulted in maintaining the current reluctance of national variety release committees to sanction multiple varieties of a crop. Yet scientists in the bean networks have become convinced that multiple releases are needed to address farmers' preferences and niches, and thereby achieve wide impact. A logical outcome was reached in that varieties will be evaluated on their merits, fewer years of testing will be required generally, on-farm testing will be more uniformly recommended before release, and procedures wil be speeded up by requiring more regular release committee meetings. Cross-border transfer, testing and sale of seed of a variety identified in one East African country will be made legally easier and quicker. On plant variety protection, farmers' rights were discussed and are to be respected.

Contributors: R. Kirkby, R. Buruchara, S. David and P. Kimani
Collaborators: ECAPAPA, ASARECA, ECABREN

Lessons from emergency seed aid in Kenya

Rationale: Every country in the Horn of Africa has experienced drought, civil disturbance or both within the last ten years —with many regions having experienced stress on a near continuous basis. Relief efforts absorb an increasing share of the aid budget, and partly at the expense of development assistance. Seed and seed system support, as distinct from food aid, is a relatively new phenomenon that still tends to be implemented under "seed and tools" programs, instead of being seen as fundamentally different from food aid. CIAT brought to this topic the experiences in leading and evaluating the Seeds of Hope project in Rwanda, and in strengthening smallholder seed systems across the region. Lessons learned could be invaluable to future efforts elsewhere.

Method: CIAT was invited to undertake this study by USAID, focusing on a single season in 1997 just after another major drought in Kenya. It examined the internal process and effects of the seed aid intervention as it unfolded in four different districts, through the Government of Kenya (GOK) and two non-governmental implementers, Catholic Relief Services (CRS) and German Agro-Action (GAA) who became partners in carrying out the study. How the seed aid was managed at the community level was examined also through a survey of 171 male and female smallholder recipients of seed aid, whose own assessments and reflections on the effectiveness of the intervention provided a perspective on the effects of these interventions on the longer-term sustainability of Kenyan farming systems.

A workshop in June 2000 on "Targeted seed aid and seed system interventions: strengthening small farmer seed systems in East and Central Africa" drew together a group of seed system and disaster management specialists to advance our understanding of: a) how to characterize the components of seed systems; b) how to distinguish among the different kinds of seed systems stresses; and c) how to start to link more accurate diagnosis of seed systems stress with a more targeted method of outside intervention support. Case studies were drawn predominantly from East and Central Africa, but also drew lessons from the Hurricane Mitch interventions in Honduras.

Results and discussion: Kenyan farmers in the semi-arid areas studied here have been experiencing *repeated acute stress.* Yet for many, the seed stresses they described were neither acute nor repeated acute, but *chronic* – due to small plots, unreliable rainfall, lack of adapted varieties, poorly adapted crops, distant markets, scarcity of cash to purchase seed.... all hindering their being able to produce and/or access sufficient quantities of seed each season.

Seed aid of maize, the lion's share of aid given, provided 14% of maize sown in Long Rains 1997, while for beans, aid seed represented 11% of the total sown. Aid seed accounted for 33% and 27% of the total seed sown for sorghum and cowpea, respectively, as aid agencies most often gave these crops expressly to diversify farmers' crop profile in drought-prone areas. Thus, during the emergency period, farmers accessed the majority of the seed by themselves for all four crops analyzed, and from local markets, not stockists, even in ecologically-stressed areas. For most farmers, seed aid supplied their full seed stock of a single crop only if the crop were 'relatively new' or 'lower priority' — the cases of cowpea, sorghum, pigeon pea and millet — or with income generating vegetables such as onion, kale and tomato.

Farmers use some seven potential channels for accessing seed. Nearly all farmers regularly used home-saved maize seed as their main source, and regularly used the local market to top-off supplies. Use of stockists to access improved varieties was key only in the Baringo (irrigated) sample; elsewhere, certified seed and hybids were used by a small proportion. Farmers overwhelmingly expressed dissatisfaction with their maize procurement strategy, with the notable exception of the irrigated Baringo area. The large majority could not afford certified seed, and complained about the local market: the right varieties not available, seed poor quality, merchants cheat on quantity, and distances.

For beans, across sites, farmers used home-saved seed stocks and local markets – and, surprisingly, most farmers reported obtaining more than half their bean seed off farm on a regular basis. Reliance on the market seemed to be rising, yet would like to be more self-reliant because buying bean seed competes with school fees, medicine and food.

Despite some positive developments — some new varieties, the emergency seed aid, the packaging of varieties in smaller packets – farmers in these semi-arid areas reported seed trends for maize and beans as having deteriorated over the last decade, with increasing prices, weaker exchange networks, deteriorating soil fertility and land fragmentation. There was no evidence that seed aid *per se* was strengthening farmer systems — those who have received it once are not necessarily less likely to receive it again. Amounts given were not significant in the context of farmers' overall seed procurement strategies. Further, the main crop given, hybrid maize, does not ensure that farmers in these areas can become less dependent on outside sources. Most farmers in the semi-arid areas, unless in an irrigated district, did not routinely access hybrid maize seed from stockists, did not have the management expertise, and may not even have had the appropriate bio-physical environment in which nurture the 'aid' varieties.

If the stress is chronic, then capacity-building crop choices may be appropriate, distributing seed of crops that can be more easily managed and sustained by farmers over seasons. For instance, farmers who are chronically short of their own home-saved seed <u>and</u> are chronically sort of cash to top off stocks with market purchases might be better off with open pollinated varieties or vegetatively propagated crops. Chronic stress also demands a more holistic seed system support approach, beyond issues of seed and variety. A paramount challenge to strengthening these systems rests in a more refined diagnosis of where the constraints and opportunities lie.

Contributor: L. Sperling (CIAT/PRGA)
Collaborators: T. Remington (CRS); Diocese of Embu; GAA; MoA; R. Kirkby. S. David.

Activity 4.6 Investigate and publicize new market opportunities and products

This activity has been developed and is being carried out entirely within the ECABREN network, which reinforced these aspects in its new breeding strategy this year (see Section 1).

PUBLICATIONS

Refereed publications

Abate, T., A. van Huis and J.K.O. Ampofo. 2000. Pest management strategies in traditional agriculture: an African perspective. Ann. Rev. Entomol.45:631-659

Buruchara, R.A. and L. Camacho. 2000. Common bean reaction to *Fusarium oxysporum* f. sp. *phaseoli*, the cause of severe vascular wilt in Central Africa. J. Phytopathology 148:39-45.

Chirwa, R.M. and V.D. Aggarwal. 2000. Bean seed dissemination systems in Malawi. Journal of Sustainable Agriculture, Vol. 15 (4): 5-24.

Songa, M. and J.K.O. Ampofo. (1999). Ecology of bean stem maggot attacking dry bean (*Phaseolus vulgaris* L.) in semi-arid areas of eastern Kenya. International Journal of Pest Management. 45: 35-40

Tilahun Amede and Yitbarek Nigatu. 2000. Interaction of components in Maize-Sweet potato intercropping systems in southern Rift-Valley, Ethiopia. Tropical Agriculture (Trinidad). In press.

Wortmann, C.S., B.D. McIntyre and C.K. Kaizzi. 2000. Annual soil improving legumes: agronomic effectiveness, nutrient uptake, nitrogen fixation and water use. African Crop Science Journal 8 (3): 1-8.

Wortmann, C.S. and C.K. Kaizzi. 2000. Tree legumes in medium-term fallows: nitrogen fixation, nitrate recovery and effects on subsequent crops. African Crop Science Journal 8 (3): 263-272.

Other publications

Ampofo, J.K.O. 2000. Participatory development of IPM with small holder farmers in northern Tanzania. Poster presentation at the GFAR Conference on Strengthening Partnership in Agricultural Research for Development in the Context of Globalization, 20-22 May, 2000. Dresden, Germany.

Buruchara, R. A. 1999. Seed health: A perspective from small-scale common bean (*Phaseolus vulgaris* L.) production in Eastern and Central Africa. Paper read at the International Workshop to develop10 year strategy for the Danish Institute for Seed Pathology, Denmark

Buruchara, R. A., R. Otsyula, F. Opio, A. Musoni, S. Kantengwa, J. Nderitu, N. Patrick and C. Wortmann. 2000. Developing and disseminating integrated pest management technologies for bean root rots in eastern and central Africa. Paper presented in the Global Forum on Agricultural Research, Dresden, Germany 23- 24 May 2000.

David, S. and S. Kasozi. 1999. "Designing sustainable, commercial farmer seed production systems in Africa: case studies from Uganda" in S. Fujisaka (ed.) Systems and farmer participatory research: development in research on natural resource management. Cali: Centro International de Agricultural Tropical.

David, S. and L. Sperling. 1999. Improving technology delivery mechanisms: lessons from bean seed systems research in eastern and central Africa. Agriculture and Human Values 16:381-388.

David, S., R. Kirkby and S. Kasozi. 2000 Assessing the impact of bush bean varieties on poverty reduction in sub-Saharan Africa: evidence from Uganda. CIAT Africa Network, Occasional Publications Series no. 31. Kampala, Uganda.

David, S. (ed.) 2000. Planning for farmers' seed requirements: Proceedings of workshops at AHI benchmark sites in Eastern Africa. AHI Technical Series No. 12. ICRAF, Nairobi, Kenya.

Dorit N. Kaluski, Einat Ophir and Tilahun Amede. 2000. Food security and nutrition - The Ethiopian case for action. The Lancet. Submitted.

Kimani, P.M. 2000. Role of food Legumes in Farming systems in Africa. Keynote paper presented at the African Biological Nitrogen Fixation Conference, 25-29 Sept 2000, Nairobi, Kenya. Selected for publication in Plant and Soil.

Kimani, P.M. 2000. Capitalization of SDC's experience in sustainable use of Natural resources and Biodiversity: The Pan African Bean Research Alliance case study. Occasional publications No?, CIAT, Kampala, Uganda.

Kimani, P.M., R. Chirwa and R. Kirkby. 2000. Bean breeding for Africa: Strategy and Plan. Paper to be presented at the KARI Conference, November 2000, Nairobi, Kenya.

Ngongo, M. and L. Lunze. 2000. Espèce d'herbe dominante comme indice de productivité du sol et de la réponse du haricot commun à l'application du compost. African Crop Science Journal, Vol 8 (3): 251-261.

Tilahun Amede, 1999. AHI as an ecoregional programme in natural resource management in East African Highlands: Paper presented at the Upland Agroforestry training workshop for South-East Asia, November 4 -29, 1999. Los Banos, The Philipines.

Tilahun Amede, 2000. The role of forage legume in the farming systems of the Central Ethiopian Highlands. Paper presented at Feed legumes workshop, Embu, Kenya. July 27-28, 2000. In press.

WORKSHOPS AND CONFERENCES

Technical meetings convened by CIAT

Regional workshop of the participatory bean breeding project, Awassa, Ethiopia, 27-31 March 2000.

Targeted seed aid and seed system interventions: strengthening small farmer seed systems in East and Central Africa, Kampala, Uganda, 21-24 June, 2000.

PRGA Symposium, Nairobi, Kenya, 6-9 November 2000.

Strategies for improved nutrient management on small farmers in Africa: regional workshop of the BMZ funded project, Kampala, Uganda, 15-16 November 2000.

African Highlands Initiative (AHI)

Meetings of Regional Steering Committee, 8-9 February and 14 November 2000.

Meetings of Technical Support Group, 16-18 May and 13-14 November, Kisumu/Nairobi, Kenya

Working group meeting on GIS, 31 May, 2000, Nairobi, Kenya.

Task force meetings on NRM policy, Kabale, Uganda.

Participatory monitoring and evaluation (PM&E) workshops, for AHI teams in Ethiopia and Madagascar, July 2000.

Seed Planning Workshops: Lushoto, Tanzania (October 26-17, 1999), Kabale, Uganda (November 10-11, 1999) and Antsirabe, Madagascar (March 15-16, 2000)

Other workshops and principal meetings

3rd International Crop Science Congress: Meeting future human needs, Hamburg, Germany.

ISAR/IITA/USAID Technology transfer project, steering committee and program meetings, Rubona, Rwanda, 18-19 January 2000.

Seeds of Freedom project, Luanda, Angola, 29-30 March 2000.

Madagascar Bean Program strategic planning workshop, Antananarivo, Madagascar, 6-8 September 2000.

Annual meeting of the IARCs/NARS Training Group for Africa (INTG), Egerton, Kenya, 7-8 November 2000.

KARI Scientific Conference, Nairobi, Kenya, 13-17 November 2000.

Management committee meetings for bean networks

Eastern and Central Africa Bean Research Network (ECABREN), Annual Meeting of Steering Committee, Nazareth, Ethiopia, 7-12 February 2000.

Eastern and Central Africa Bean Research Network (ECABREN), Establishment of ECABREN Research Framework, Nairobi, Kenya, 19-22 March 2000.

Pan African Bean Research Alliance (PABRA): annual meeting of the steering committee. Mzuzu, Malawi, 1-65 May 2000.

Southern Africa Bean Research Network (SABRN), Annual Meeting of Steering Committee, Lusaka, Zambia, 16-18 October 2000.

Eastern and Central Africa Bean Research Network (ECABREN), Special Planning Meeting of Steering Committee, Nairobi, Kenya, 25-28 October 2000.

Meetings of the Global Forum and the Sub-regional Research Organizations

ASARECA seed policies harmonization workshop, Entebbe, Uganda, 4-5 April 2000.

Annual Plenary Meeting of the Special Program for African Agricultural Research (SPAAR), Conakry, Guinee, 9-14 April 2000.

GFAR Conference on Strengthening Partnership in Agricultural Research for Development in the Context of Globalization, 20-22 May, 2000. Dresden, Germany.

ASARECA natural resources management strategy workshop, Nairobi, Kenya, 14-16 February 2000.

ASARECA annual consultative forum for work plan review and programming, Antananarivo, Madagascar, 7-13 July 2000.

ASARECA annual meeting of the Committee of Directors, Nairobi, 16-17 November 2000.

SACCAR annual meeting of the Technical Committee for Agricultural Research and Training, Maputo, Mozambique, 22 November 2000.

TRAINING EVENTS

Crop Management Research Training (CMRT) course, Egerton University, Njoro, Kenya, 15 Feb to July 30, 2000.

Business Awareness Training Course for Makiba Farmers' Groups in northern Tanzania, Matiba, Tanzania, 8-10 March 2000.

SWNM/AHI regional workshop on tools for social analysis and soil quality indicators, Mukono, Uganda, 20-31 March 2000.

ASARECA Website Development Training Workshop, Entebbe, Uganda, 18-22 September 2000

INTG/ISNAR Agricultural Research Management Training for NARS Program Leaders in sub-Saharan Africa, Msiri, Mauritius, 2-14 October 2000.

Monitoring and Evaluation Training Course, TCDC, Usa River, Tanzania, 30 October to 3 November 2000.

DONORS

Donor	Project	Duration of current funding
ICRAF (donor consortium to AHI)	Ecoregional research on IPM, seed systems and systems intensification	1998-2000
CIDA (Canada)	Pan-Africa Bean Research Alliance	1996-2000 2000-2002
DFID (UK)	Participatory Plant Breeding	1998-2001
HRI (from DFID)	Epidemiology of bean root rots	2000-2003
ICRISAT (from USAID)	Seeds of Freedom (Angola)	1997-2000
IDRC (Canada)	Social Science Internship (Ethiopia)	1999-2000
SDC (Switzerland)	Pan-Africa Bean Research Alliance	1998-2001
	Associate Expert in Agronomy (Tanzania)	1998-2001
USAID (USA)	Eastern and Central Africa Bean Research Network	1998-2002
	Study of Seed Relief in Kenya	1997-2000

Notes:

ECABREN: activities reported here are supported financially by the member Governments of ASARECA, and by CIDA, SDC and USAID as the donors to PABRA.

Southern Africa Bean Research Network (SABRN): activities reported here are supported financially by SACCAR, the member Governments of SADC countries, and by the donors to PABRA.

STAFF LIST

Principal staff

*Adamo, Abra, MA, Sociologist (stationed in Nazreth, Ethiopia)
Amede, Tilahun, PhD, Systems Agronomist (AHI) (stationed in Areka, Ethiopia)
Ampofo, Kwasi James, PhD, IPM Specialist, Site Coordinator (stationed in Arusha, Tanzania)
Buruchara, Robin, PhD, Plant Pathologist (stationed in Kampala, Uganda)
** Chirwa, Rowland, PhD, Plant Breeder (stationed in Lilongwe, Malawi)
David, Soniia, PhD, Sociologist (stationed in Kampala, Uganda)
Delve, Robert, PhD, Postdoctoral Fellow (TSBF/CIAT SWNM) (stationed in Kampala, Uganda)
Esilaba, Anthony, PhD, Participatory Management of Soil Fertility (SWNM) (stationed in Kampala, Uganda)
Hollenweger, Ursula, MSc, Agronomist (stationed in Arusha, Tanzania)
**Kimani, Paul, PhD, Plant Breeder for ECABREN (University of Nairobi/CIAT) (stationed in Nairobi, Kenya)
Kirkby, Roger, PhD, Systems Agronomist, Project Manager (stationed in Kampala, Uganda)
Mukishi, Pyndji, PhD, Plant Pathologist, ECABREN Coordinator (stationed in Arusha, Tanzania)
Sanginga, Pascal, PhD, Sociologist (PRGA) (stationed in Kabale, Uganda)

Research assistants

Bashieja, Henry, Laboratory Technician (Pathology) (stationed in Kampala, Uganda)
*Eledu, Charles, MSc, Research Associate, GIS (stationed in Kampala, Uganda)
*Kasozi, Sarah, BSc, Research Assistant, Sociology (stationed in Kampala, Uganda)
*Lyimo, Jackson, Field Assistant (stationed in Arusha, Tanzania)
Massomo, S.M.S, BSc. Research Assistant (on unpaid study leave from Arusha, Tanzania)
Mohamed, Daima, Field Assistant (IPM) (stationed in Arusha, Tanzania)
**Mziray, Hendry, Research Assistant (stationed at Arusha, Tanzania)
Nalukenge, Grace, Dip., Field Assistant (Systems) (stationed in Kampala, Uganda)
Suleiman, Sebuliba, Field Assistant (Breeding) (stationed in Kampala, Uganda)

Administrative staff

Amuza Babi, Driver/Mechanic (stationed in Kampala, Uganda)
Baguma Athanasio, Driver/Administrative Assistant (stationed in Kampala, Uganda)
Gamba, Abdalla, Security Guard (stationed at Arusha, Tanzania)
*Kamulindwa, Julius, B.Com., Regional Finance and Administration Officer (stationed in Kampala, Uganda)
Laizer, Emeseiki, Security Guard (stationed at Arusha, Tanzania)
Nampeera Teo, Dip. Acc., Accounts Assistant (stationed in Kampala, Uganda)
**Nassozi, Sarah, B.Com., Regional Finance and Administration Officer (stationed in Kampala, Uganda)
Ndolwa, Miraji, Driver/mechanic (stationed at Arusha, Tanzania)
Ngalo, Eva, Secretary (stationed at Arusha, Tanzania)
Shirima, Julita, Messenger/cleaner (stationed at Arusha, Tanzania)
Tibalikwana Mabel, Exec. Secretary (stationed in Kampala, Uganda)
Travas, Betty, Administrative Assistant (stationed at Arusha, Tanzania)

* Left CIAT during 2000
** Joined during 2000

INSTITUTIONAL ABBREVIATIONS

Africa2000	Africa2000 Network (of the United Nations)
AHI	African Highlands Ecoregional Programme (led by ICRAF)
ARC	Agricultural Research Corporation, Sudan
ARC/GCRI	Agricultural Research Council, Grain Crops Research Institute, South Africa
ASARECA	Association for Strengthening Agricultural Research in Eastern and Central Africa
AU	Alemaya University, Ethiopia
BMZ	German Federal Ministry for Economic Cooperation and Development
CARE	(International NGO in Ethiopia, Rwanda, Uganda)
CIDA	Canadian International Development Agency
CMRT	Crop Management Research Training Course, Egerton University, Kenya
CRS	Catholic Relief Services
CRSP	Collaborative Research Support Project (of USAID)
DARTS	Department of Agricultural Research and Technical Services, MoA, Malawi
DFID	Department for International Development (UK)
DR Congo	Democratic Republic of Congo
DRD	Department of Research and Development, Ministry of Agriculture, Tanzania
EARO	Ethiopian Agricultural Research Organization
ECABREN	Eastern and Central Africa Bean Research Network
ECAPAPA	Eastern and Central Africa Policy and Planning Network of ASARECA
TCDC	MS-Training Centre for Development Cooperation (Tanzania)
FAIDA-SEP	Finance and Advice in Development Assistance for Small Enterprise Promotion
FOFIFA	Centre National de la Recherche Appliqué au Développement Rural, Madagascar
GAA	German Agr-Aktion
ICRAF	International Centre for Research in Agro-Forestry
ICRISAT	International Crops Research Institute for the Semi Arid Tropics
IFDC	International Fertilizer Development Center, Africa Regional Program, Togo
INERA	Institut National des Etudes sur la Recherche Agronomique, DR Congo
INIA	Instituto Nacional de Investigacao Agricola, Mozambique
ISAR	Institut des Sciences Agronomiques du Rwanda
KARI	Kenya Agricultural Research Institute
MoA	Ministry of Agriculture
MU	Makerere University, Uganda
NARI	National agricultural research institute
NARO	National Agricultural Research Organisation, Uganda
NARS	National agricultural research system
NGO	Non-governmental organization
PABRA	Pan-Africa Bean Research Alliance
PNL	Programme National Légumineuses, DR Congo
REDSO	Regional Economic Development Services Office, USAID
SABRN	SADC Bean Research Network
SACCAR	Southern African Centre for Cooperation in Agricultural and Natural Resources Research and Training
SADC	Southern Africa Development Community
SARI	Selian Agricultural Research Institute, DRD, Tanzania

SPAAR	Special Program for African Agricultural Research
SDC	Swiss Agency for Development and Cooperation
SWNM	Soil, Water and Nutrient Management,a system-wide prógram of the CGIAR
TSBF	Tropical Soil Biology and Fertility Program
UoN	University of Nairobi
USAID	United States Agency for International Development
WVI	World Vision International