# ANNUAL REPORT

# 1997

# 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

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# 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 modelling 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 bean 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 |

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# Research Highlights in 1997

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

### Achievements

- South Africa s NARS provided more specialized support to other members of SABRN network
- The ECABREN network which was favorably reviewed by one of its donors is promoting reasearch to extend the introduction of high yielding climbing beans to two more countries
- An innovation in the networks use of experienced national scientists as resource persons was ECABREN s use of a Kenyan economist to lead an adoption study in Tanzania
- Partnerships in Malawi s bean improvement program were strengthened
- Networks merge in Eastern and Central Africa under auspices of the regional NARS association
- A first meeting of the Steering Committee of the Pan Africa Bean Research Alliance (PABRA) formalized coordination among regional bean networks in Africa CIAT and donors
- A second decentralized Multidisciplinary Course for scientists from 7 countries included the development of individual research proposals for submission to the networks
- Project IP 1 equipped two experienced bean breeders from Africa with specialized skills in gametic selection
- The project on Participatory Research for Improved Agro ecosystem Management (PRIAM) held workshops at six sites in four countries to reach agreement with farmers researchers and extension staff on research agenda
- Over 60 scientists from national programs and CIAT presented and discussed their results at ECABREN s first triennial Multidisciplinary Workshop
- A strategic planning workshop extended the priorities of the SABRN network from germplasm to systems improvement and technology transfer
- The African bean database including data on 57 variables for 96 bean production areas was revised and analyzed the database is ready for distribution to GIS practitioners and a draft of an atlas has been submitted to publication

- Information on the distribution of bean seed types has been analyzed and published with the expectation that it will better enable breeders to target new varieties

- Separate cultivation of beans by men and women farmers has implications for food security varietal choice and the intensity of production

- Among Ugandan farmers the consumption of beans fluctuates in accordance with its availability and that of other foods

- While bean stem maggot is recognized across Africa as the most important main season pest of bean surveys in Malawi have shown that aphids are more challenging to the winter crop and that farmers have less knowledge of potential control measures for these pre harvest pests than for bruchids in stored beans which are therefore better controlled

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

- The DSSAT Drybean model was used to test bean ideotypes early maturing varieties gave most yield and stability in those rainfall zones more stressed by water deficits

- Characterization of pathogenic diversity in angular leaf spot (ALS) isolates identified in addition to the Andean and Mesoamerican groups an Andean sub group of 12 races that attack a few Mesoamerican varieties

- Mixed occurrence of the main ALS pathogen groups and detection of the Andean sub group are significant distinguishing features of pathogen diversity between Latin America and Africa diversity information is being used to develop race maps for Africa

- CIAT and national bean materials were identified with resistance to both Andean and Mesoamerican pathogen groups of angular leaf spot (ALS) the value of using characterized diversity selectively in germplasm evaluations was confirmed

- Four medium/large seeded Andean and 24 small seeded Mesoamerican lines exhibited good tolerance to both Andean and Mesoamerican local strains of ALS some of these lines are also resistant to BCMNV and outyielded released varieties

- One hundred and fourteen lines combined resistance to the virus diseases BCMV and BCMNV with good yield potential and several large seeded BCMV/BCMNV resistant lines with export potential entered pre release multiplication with Uganda Seeds Scheme

- Eight lines were identified as resistant to common bacterial blight (CBB) five of which outyielded MCM 5001 46 lines had good tolerance to CBB and some were also resistant to BCMNV

- Well adapted lines have been identified with resistance or good tolerance to two or three of the important biotic constraints BCMNV ALS and CBB

- A total of 748 entries from CIAT and national sources were evaluated for resistance to Pythium and Rhizoctonia root rots none was resistant but 122 gave an intermediate reaction Promising materials were re evaluated and 39 were distributed to partners

- Sixty four entries were confirmed as highly resistant sources against anthracnose and 24 climbing bean entries were selected for regional distribution

- Significant varietal differences in tolerance to BSM were observed in Malawi and three recently released varieties showed high levels of tolerance

- Two bean varieties consistently showed tolerance in Malawi to both low P and low N constraints

- A wide range of germplasm was evaluated on station and on farm in Malawi and several promising lines were identified

- The PRIAM project is supporting the breeding research of an expert farmer in one of its participating Ethiopian communities and his experiences are starting to change the outlook of the formal system

- A new collaborative research program on participatory bean breeding was designed with scientists from several ECABREN countries

- A first regional root rot nursery was constituted and distributed

- Two regional nurseries were distributed from Malawi to the national programs in the SADC region, and superior genotypes were identified

- Skills in gametic selection are being transferred to two selected bean breeders from national institutions

- Several national scientists prepared sub project proposals aimed at better targeting and use of germplasm

## Output 3 Sustainable bean production systems

- Nutrient balances in the banana based land use type were near zero for N positive for P and negative for K while balances were negative for all nutrients in the annual crop land use type

- Better P nutrition improved bean productivity and increased the percent of N derived from biological nitrogen fixation from 20 to 38%

- Confirmation was obtained for Malawi that host plant resistance and soil amendments can provide reasonable control of stem maggot

- Using standardized neem products from GTZ IPM Horticulture we were able to demonstrate an additive interaction between plant resistance and neem treatments

- A better understanding was obtained of *Ootheca* leaf beetle biology and phenology this knowledge is already helping farmers in Tanzania to develop simple management strategies

- Farmer research groups were formed in two villages in northern Tanzania following several years informal PR on IPM strategies one group has chosen to focus on cultural management of BSM and the other on testing resistant varieties

- Farmers in western Kenya are well aware of the current epidemic of bean root rots which was diagnosed as being due to *Pythium* spp and *Fusarium solani* farm yard manure inorganic fertilizers and ridging were moderately effective in reducing plant mortality

- In a yield loss assessment in Malawi fungal diseases caused more damage and were easier to control than bacterial diseases and new resistant varieties provided good protection and higher yields

- A thesis on mechanisms of low P tolerance indicated that basal root growth was related to yield performance under low P conditions amongst small seed varieties and efficiency for uptake of scarce P from the soil was more important than metabolic use efficiency and P harvest index

- Promising BILFA II entries obtained approximately 38% of their N from the atmosphere and were much less responsive to N application than the non nodulating lines

- A research framework for the diagnostic stage of the PRIAM project has been developed tested and refined research on the Experimentation Monitoring and Evaluation and Dissemination stages of the project are in progress

- A study of methods for assessing farmers independent experimentation in Uganda produced information that was used in developing a decision guide to use of green manure /cover crops

- We participated in all three research themes of the African Highlands Initiative the ecoregional program for Eastern Africa aspects are described elsewhere in this report

- Our training activities were coordinated other IARCs through the IARCs/NARS Training Group for Africa (INTG)

## Output 4 Technology adopted

- Markets constitute an important source of bean seed for nearly a third of farmers surveyed in Malawi

- Small scale Ugandan farmers can ably produce and market bean seed but without initial financial support their level of production remains low

- Tanzanian stockists are willing to sell and promote seed of new bean varieties

- More than 50 tonnes of seed of newly released varieties were multiplied in Malawi

- Informal seed dissemination through traders extension staff and NGOs proved successful following a promotional campaign

- Seed for 1500 on farm trials and 4 tonnes of bulk seed of improved varieties were supplied by Malawi to NGOs in Angola

- Facilitating farmer to farmer transfer of knowledge is increasing the adoption rate of climbing beans in Uganda but farmer led extension must find solutions to organizational and logistical problems

- Information including a decision guide on green manures and cover crops was disseminated through numerous partners

- Decentralized dissemination of root rot resistant bean varieties was facilitated in Rwanda while root rot management was promoted by a poster in Rwanda and a local TV documentary in Kenya

- Ugandan farmers benefit financially from growing new bean varieties

- Farmers having longer association with researchers were better informed about pests and were more aware of IPM strategies

# IP 2 Meetıng Demand for Beans ın Sub-Saharan Afrıca ın Sustaınable Ways

## Output 1 Stronger networks ın Afrıca lınkıng NARS, IARCs, NGOs and the prıvate sector

## Actıvıty 1 1 Develop new partnershıps wıthın regıonal networks

### Achıevements

- South Afrıca s NARS provıded more specıalızed support to other members of SABRN network
- The ECABREN network whıch was favorably revıewed by one of ıts donors ıs promotıng reasearch to extend the ıntroductıon of hıgh yıeldıng clımbıng beans to two more countrıes
- An ınnovatıon ın the networks use of experıenced natıonal scıentısts as resource persons was ECABREN s use of a Kenyan economıst to lead an adoptıon study ın Tanzanıa
- Partnershıps ın Malawı s bean ımprovement program were strengthened

*Innovatıons wıthın the southern Afrıca network*

**Contrıbutors** **R Kırkby Dr C Mushı (DRT/SABRN)**
**Collaborators** **Dr A Lıebenberg and colleagues (ARC) natıonal programs ın SABRN**
**Sponsor** **SACCAR**

South Afrıca s natıonal bean program wıthın the Agrıcultural Research Councıl (ARC) ıs partıcularly strong ın advanced research technıques Its partıcıpatıon ın the Southern Afrıca Bean Research Network (SABRN) has developed steadıly ın the past three years and thıs has opened several new opportunıtıes for strategıc research and specıalızatıon for effıcıency under condıtıons of resource constraınts

The first three regıonal sub projects taken on by South Afrıca, and whıch are currently ın progress aım to ıdentıfy pathogen race dıstrıbutıon for ımproved resıstance breedıng agaınst ALS CBB and rust by natıonal programs throughout the SADC regıon In the Eastern Afrıca regıon thıs work ıs led maınly by CIAT Coordınatıon among CIAT projects IP 1 and IP 2 and the work of South Afrıca ıs ıntended to ensure that laboratory results from the two regıons are comparable Thıs year South Afrıca s ınvolvement grew further wıth approval of a sub project to develop a mass rearıng method for use by natıonal programs and CIAT ın screenıng bean lınes resıstant to stem maggot

Although SABRN continues to be constrained by lack of a special project donor the Southern Africa Centre for the Coordination of Agricultural Research and Training (SACCAR) has funded a small core set of research sub projects (Table 1) Network coordination is the responsibility of Tanzania s national bean coordinator while Malawi s coordinator has network responsibility for germplasm exchange neither regional function is remunerated

Table 1 Regional research sub projects implemented by SABRN countries in 1997/98

| Title | Country | Institution | Year approved |
|---|---|---|---|
| Breeding for tolerance to drought | Tanzania | SUA | 1995 |
| Breeding for bruchids resistance | Tanzania | SUA | 1994 |
| Dissemination of new varieties | Lesotho<br>Malawi<br>Mozambique<br>Tanzania | MOA Maseru<br>DARTS Chitedze<br>INIA<br>DRT Selian | 1995 |
| Pathogenic variation of rust | South Africa | ARC Grain Crops Institute | 1995 |
| Bacterial diseases | South Africa | ARC Grain Crops Institute | 1995 |
| Physiological races of angular leaf spot | South Africa | ARC Grain Crops Institute | 1995 |
| Dissemination of new varieties | Zambia | MOA | 1997 |
| First and secondary multiplication of two varieties | Angola | MOA | 1997 |
| Evaluation of BSM resistant lines in Southern Highlands | Tanzania | DRT Uyole | 1997 |
| Ootheca management in Southern Highlands | Tanzania | DRT Uyole | 1997 |
| Farmer participation in selection and seed multiplication | Zambia | MOA | 1997 |
| Mass rearing for resistance breeding against bean stem maggot | South Africa | ARC Grain Crops Institute | 1997 |

*Innovations within ECABREN*

**Contributor** **P Mukishi (CIAT/ECABREN)**
**Collaborators** **Mercy Kamau (KARI) national programs in ECABREN ASARECA**
**Sponsors** **USAID SDC CIDA**

With population pressure growing in most of the African highlands and increasing degradation of arable lands promoting the production of climbing beans accompanied by the introduction of agroforestry trees for staking is an excellent opportunity to combine rapid productivity increase with conservation This year partners in the Eastern and Central Africa Bean Research Network (ECABREN) agreed to start testing the technology in new areas through four sub projects in Kilimanjaro and Kagera regions (Tanzania) and southern and eastern Ethiopia (Table 2) Initial results appear to confirm the adaptability of several materials selected in the Great Lakes Region

The rapid adoption of climbing beans beyond their original area of impact in Rwanda during recent years when the bean program of Rwanda has been severely weakened has led to concern about ability to meet the demand for newer materials Fortunately some research on climbing beans has continued in Rwanda which has dedicated and trained technicians who are handling the selections Materials recently identified by them are judged to be worth immediate testing in other network countries and a new ECABREN nursery has been constituted and is expected to boost bean research in the network

Specially funded adoption and marketing studies of improved bean varieties in southern and in northern Tanzania were carried out by an agricultural economist from the Kenya Agricultural Research Institute (KARI) in collaboration with Tanzania s Department of Research and Training This kind of research use of a regional resource specialist by the Network represented an advance in regional collaboration over the now commonly practiced cross country sharing of manpower for training and advice Another varietal adoption study was carried out locally in Ethiopia under ECABREN auspices by experienced staff of Alemaya University

Table 2 Regional research sub projects implemented by ECABREN countries in 1997

| Planning Objective | Title | Country | Institution/ Station | Startup |
|---|---|---|---|---|
| Intensification of production in high potential/export areas | | | | |
| Integrated pest management | Irrigated bean whitefly IPM | SDN | ARC Hudeiba | 95 |
| | Snap + dry bean nematode resistance | KYA | KARI Thika | 96 |
| | Acanthoscelides bruchid management | UGA | NARO Kawanda | 97 |
| Development Dissemination & adoption of high yielding varieties | Decentralized seed production | ETH | IAR Nazreth | 95 |
| | Adoption of Lyamungu varieties | TZA | DRT Selian | 93 |
| | Genetic improvement | MDG | FOFIFA Tana | 97 |
| | Seed channels non formal dissemination | KYA | KARI Katumani/ | 97 |
| | | | Kakamega/Thika | 97 |
| Post harvest improvement | Popularization & promotion of bean | ETH | IAR Nazreth | 97 |
| | Regional recipes | MRU | MSIRI Reduit | 96 |
| | Post harvest effects on cooking time/tast | RWA | ISAR Rubona | 96 |
| Enhancing productivity of low income farmers, predominantly women | | | | |
| Integrated crop/soil productivity | FPR on Soil Productivity | ETH | IAR Nazreth | 94 |
| | Acid Soils Management ITK | MDG | FOFIFA Tana | 95 |
| | Response Farming | KYA | KARI Katumani | 95 |
| | Soil Organic Matter | UGA | NARO Kawanda | 95 |
| | Impact of FPR | UGA | NARO Namulonge | 96 |
| | Biological Nitrogen Fixation | KYA | Univ of Nairobi | 96 |
| | Rhizobium Flora | RWA | ISAR Rubona ISAR | 97 |
| | Effect of lime and rock phosphate | RWA | Rubona | 96 |

Table 2 continued

Table 2 (continued) Regional research sub projects implemented by ECABREN countries in 1997

| Planning Objective | Title | Country | Institution/ Station | Startup |
|---|---|---|---|---|
| Varietal tolerance to biotic/abiotic constraints | Bean Improvement for Low Fertility Soils in Africa (BILFA) | | | 95 |
| | low N | ETH | IAR Nazreth | |
| | low P | ETH | Alemaya Univ | |
| | low P | KYA | KARI Kakamega | |
| | low N + P | UGA | CIAT Kawanda | |
| | low N + P | TZA | DRT Selian | |
| | low P/low pH | MDG | FOFIFA Tana | |
| | low N + P | RWA | ISAR Rubona | |
| | low pH | DRC | INERA Mulungu | |
| | seed multiplication | MWI | CIAT Lilongwe | |
| | Disease resistance rust | ETH | IAR Nazareth | 95 |
| | Disease resistance anthracnose | MDG | FOFIFA Tana | 95 |
| | Selection for anthracnose resistance | RWA | ISAR Rubona | 96 |
| | Anthracnose pathology | BDI | UNIBU | 95 |
| | Bacterial blight use of resistance sources | DRC | PNL M vuazi | 95 |
| | Multiple resistance low elevation | DRC | PNL Gandajika | 93 |
| | ALS variability & screening | KYA | Univ of Nairobi | 97 |
| | Charcoal rot regional nursery | KYA | KARI Katumani | 96 |
| | Adaptation climbing beans ecol zones | RWA | ISAR Rubona | 97 |
| | Apoderus effect on seed yield | MDG | FOFIFA Tana | 97 |
| | Anthracnose regional nursery | ETH | IAR Ambo | 97 |
| | Germplasm conservation in Congo | DRC | PNL Mulungu/ | 97 |
| | | | Gandajika/M vuazi | 97 |
| | BDI Germplasm conservation | RWA | ISAR Rubona | 97 |

Countries key BDI = Burundi ETH = Ethiopia KYA = Kenya MDG = Madagascar MRU = Mauritius DRC = Congo (ex Zaire) RWA = Rwanda SDN = Sudan TZA = Tanzania UGA = Uganda

### *A stronger national program in Malawi*

**Contributors** V Aggarwal Dr C Chirwa (DARTS)
**Collaborators** Dr A Mkandawire and colleagues (Univ of Malawi Bean/Cowpea CRSP)
**Sponsors** DFID USAID GoM

The Malawi Bean Improvement Project a partnership between the Department of Agricultural Research and Technical Services (DARTS) CIAT and the Department for International Development of the UK (DFID) aims to develop research capacity address a serious decline in protein supply for the population and strengthen a key country member of the SADC Bean Research Network The program in which the national coordinator and a CIAT breeder share certain responsibilities uses semi annual meetings to bring together both DARTS and the University of Malawi in complementary areas of bean research to plan for support needs from the CIAT/PABRA team and to discuss progress reports Collaboration with PABRA and with SABRN includes evaluating nurseries non formal training in evaluating disease resistance and pathogen diversity and socio economic surveys

## Activity 1 2 PABRA members coordinate and take greater responsibility for managing regional networks

## Achievements

- Networks merge in Eastern and Central Africa under auspices of the regional NARS association
- A first meeting of the Steering Committee of the Pan Africa Bean Research Alliance (PABRA) formalized coordination among regional bean networks in Africa CIAT and donors

*Merger of regional bean networks for Eastern and Central Africa*

**Contributor** **P Mukishi (CIAT/ECABREN)**
**Collaborators** **National programs of Eastern and Central Africa ASARECA**
**Sponsors** **USAID SDC CIDA**

The merger of two regional bean networks namely the Eastern Africa bean Research Network (EABRN) and the Reseau pour l Amelioration du Haricot (Phaseolus) dans la Region de l Afrique Centrale (RESAPAC) was completed this year as requested by the Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA) The Eastern and Central Africa Bean Research Network (ECABREN) is thus born under the auspices of g1 ASARECA, which now oversees policy for a small family of commodity and thematic networks ECABREN counts 10 members Burundi Congo (Democratic Republic formerly Zaire) Ethiopia, Kenya Madagascar Mauritius Rwanda Sudan Tanzania and Uganda Although DRT s Selian Agricultural Research Institute in Arusha Tanzania was selected by ASARECA as the Network s initial base for coordination Dr Pyndji Mukishi has operated this year from Kawanda, Uganda, pending Tanzania s final decision

For its first year of functioning ECABREN s Steering Committee approved and funded a mix of new sub projects addressing network priorities and objectives and some continuing topics from the superceded network (Table 2) Ten sub-projects were completed and two were suspended for lack of progress and/or reporting Due to troubles in the region some ECABREN members were unable to contribute fully to the implementation of Network activities The participation of Burundi and Sudan have been limited and although Congo s main station facilities and scientists were seriously affected by the brief civil war and network sub projects could not be considered technical staff and a remaining researcher devotedly rescued sufficient germplasm to ensure immediate continuity of research activities

ECABREN s Steering Committee reporting to ASARECA s Committee of [NARS] Directors applied governance procedures largely adopted from EABRN and RESAPAC This decision was reinforced by a favorable external review of EABRN published this year by USAID

*The Pan Africa Bean Research Alliance (PABRA)*

**Collaborators ASARECA SACCAR C Mushi (DRT Tanzania and SABRN Coordinator)**
**Sponsors CIDA SDC USAID**

A Steering Committee was convened this year for the Pan Africa Bean Research Alliance (PABRA) Participants were the network coordinators for ECABREN and SABRN the Executive Secretary of ASARECA representatives of CIDA, SDC and USAID as the three current donors to PABRA and CIAT s Africa coordinator (Project Manager for IP 2) Uganda s Bean Program coordinator also participated as host institution

## Activity 1 3 Technical support and participation in network training, information and planning

### Achievements

- A second decentralized Multidisciplinary Course for scientists from 7 countries included the development of individual research proposals for submission to the networks
- Project IP 1 equipped two experienced bean breeders from Africa with specialized skills in gametic selection
- The project on Participatory Research for Improved Agro ecosystem Management (PRIAM) held workshops at six sites in four countries to reach agreement with farmers researchers and extension staff on research agenda

*PABRA multidisciplinary course*

**Contributors** **P Mukishi H Gridley R. Kirkby**
**Sponsors** **CIDA SDC USAID DFID**

A 7 week multi disciplinary training course for scientists from both regional networks was funded through PABRA and organized by CIAT and ECABREN The first one month session held in Kenya at the Crop Management Research Training Course (CMRT/Egerton University) and organized by their staff covered a core set of basic research methods and techniques Each participant spent the second month on a more specialized attachment to an individual CIAT scientist according to individual needs entomologists at Arusha Tanzania and Kawanda, Uganda in the case of other disciplines Participants were 13 scientists (breeders agronomists and entomologists) from four ECABREN and three SABRN countries Experienced scientists leading network sub projects in Ethiopia Kenya and Tanzania as well as the ECABREN Coordinator CIAT/PABRA staff and CMRT staff served as the resource persons During the second period each participant also developed a research proposal potentially for network funding

Other training and information activities held by ECABREN are shown in Table 3

Table 3 Principal information exchange and training events of ECABREN in 1997

| Event | Purpose | Venue |
|---|---|---|
| First Multi disciplinary Workshop | To review research during the past 3 4 years review network priorities assist integration within ECABREN | Embu Kenya |
| Breeding Working Group | To review priorities in the area of bean breeding | Embu Kenya |
| Sugarcane/Bean Monitoring Tour | To observe intercropping of sugarcane with bean and evaluate the potential of the system | Kisumu Kenya |
| Seed Systems Monitoring Tour | To expose a regional group to formal and informal seed production and review opportunities and constraints | Kampala Masindi Mbale (Uganda) |
| Multi disciplinary Training Course | To provide a general introduction to a range of research disciplines and to expose each participant to more specialized training with CIAT staff | CMRT/Egerton University (Kenya)<br>Kampala (Uganda)<br>Arusha (Tanzania) |

***Transfer of skills from CIAT to experienced African scientists gametic selection for bean breeders***

**Contributor** **R Kirkby**
**Collaborators** **Dr P Kimani (University of Nairobi) Dr R. Chirwa (DARTS)**
**S Singh (IP 1) V Aggarwal H Gridley**
**Sponsors** **CIDA DFID SDC**

Most national programs in Africa have advanced greatly in scientific capabilities and achievements over the past 10 years even though many scientists struggle under difficult economic and infrastructural conditions The form and content of CIAT s scientific collaboration with our partners in Africa continues to evolve The example of the Kenyan agricultural economist assisting her Tanzanian neighbors in carrying out adoption and marketing studies (see Section 1 1 above) would have been unthinkable from several points of view a few years ago

Part of our strategy for absorbing the effects of last year s budget cuts upon expected germplasm outputs for Africa from CIAT Cali is to encourage the stronger NARS in Africa to take a still more active role in developing technologies for their region Bringing into regional service South Africa s excellent laboratory facilities and skilled scientists (also Section 1 1 above) is one facet

Another ıs supportıng natıonal programs to establısh key competence ın the strategıc generatıon of germplasm on behalf of the regıon
A start ıs beıng made at the end of thıs year by equıppıng two experıenced bean breeders from Afrıca wıth specıalızed skılls ın gametıc selectıon a technıque used ın CIAT Project IP 1 ın Calı The natıonal breeders were selected from network partıcıpants on the basıs both of theır ındıvıdual comparatıve advantage and theır ınstıtutıons commıtment to undertakıng thıs functıon for the next few years It ıs expected that the task of addressıng bean breedıng prıorıtıes that receıve regıonal attentıon (see Sectıon 2 2 below) wıll be shared among these scıentısts and CIAT staff and that ıf successful the approach wıll be extended to more programs

### *Fıeld workshops for partıcıpatory research*

**Contrıbutor** **C Farley**
**Collaborators** **NARS ARC AUA FOFIFA IAR KARI NARO**
**NGOs CARE Madagascar CARE Uganda EAT FAFIALA FARM Afrıca**
**Mınıstrıes of Agrıculture Ethıopıa Kenya Madagascar Kenya**
**IARCs ICRAF/AHI IITA**
**Sponsor** **Rockefeller Foundatıon**

The project on Partıcıpatory Research for Improved Agro ecosystem Management (PRIAM) held workshops thıs year at five more sub project sıtes ın three countrıes wıth the dual aıms of provıdıng practıcal traınıng ın partıcıpatory approaches and technıques and of startıng ımplementatıon though reachıng agreement wıth farmers on a research agenda Workshop partıcıpants ıncluded NARI researchers NGO staff members extensıon agents and farmers

Each 9 day workshop started wıth a two day ıntroductıon to partıcıpatory research concepts and methods for researchers and for NGO and extensıon staff Subsequently four days were devoted to characterızatıon and dıagnostıc actıvıtıes undertaken wıth farmers ın the sub project communıty For the followıng two days researchers revıewed the ınformatıon and developed a prelımınary research program whıch was presented to farmers on the last day for refinement wıth them so as to reflect theır ınterests

The resultıng research programs that are now ın progress cover a dıversıty of topıcs These ınclude trıals or demonstratıons on crop varıetıes (e g maıze beans rıce wheat vegetables) agrıcultural ımplements (e g row planters) and soıl fertılıty management trıals (e g compost makıng ımproved FYM management A farmer research commıttee and a core team of five to sıx researchers were selected to facılıtate ımplementatıon of the sub project at each PRIAM sıte

Locations were as follows

Ethiopia Awassa Research Center July 1996
(Participants 6 researchers 2 extension agents 1 NGO staff)

Uganda Kabale January 1997
(Participants 2 researchers 1 extension agent)

Kenya Kitale National Agricultural Research Institute February 1997
(Participants 9 NARI researchers 5 extension agents 3 NGO staff)

Kenya Kisii Regional Research Center July 1997
(Participants 21 RRC researchers 5 extension agents)

Madagascar FOFIFA Sub Station Antsirabe March 1997
(Participants 68 researchers 1 extension agent 3 NGO staff)

Uganda CIAT/IITA Kabale August 1997
(Participants 8 NARI researchers)

## Activity 1 4 Efficient modes of managing networks

### Achievements

- Over 60 scientists from national programs and CIAT presented and discussed their results at ECABREN s first triennial Multidisciplinary Workshop
- A strategic planning workshop extended the priorities of the SABRN network from germplasm to systems improvement and technology transfer

**Contributors** **P Mukishi (CIAT/ECABREN) C Mushi (DRT/SABRN)**
**Collaborators** **R Kirkby and CIAT IP2 staff**
**Sponsors** **USAID SDC CIDA SACCAR**

ECABREN s first multi disciplinary workshop drawing together most Francophone and Anglophone bean scientists from the new Network region was an important occasion to disclose the research quality and the potentialities that different NARS have to offer in terms of human resources and performance Moreover this was an opportunity to identify possible resource persons that the Network may use in some of its activities such as research advice and teaching This workshop benefited greatly from simultaneous French English translation

SABRN s steering committee decided to expand its membership in the interests of enhanced collaboration in research so as to include the Africa chairman of the Bean/Cowpea CRSP Mauritius which has recently joined the SADC grouping is to decide whether they wish to switch membership to SABRN from ECABREN SABRN s procedures for approving new sub projects were reviewed and the following criteria were agreed priority of the topic for the region extent to which region collaboration is to involved urgency soundness/quality cost expected impact or benefit and format of the proposal

SABRN held a strategic planning workshop to review network priorities which was hosted by the Malawi program Participatory planning techniques were used moderated by CIAT s PABRA coordinator The network s revised priorities now extend the sphere of action from germplasm improvement to systems improvement and technology transfer The revised set of priorities are

| | |
|---|---|
| Breeding | CBB ALS HB BSM aphids bruchids Low N and P and drought the regional nurseries coordinated by the Malawi program will continue |
| Agronomy | Low soil N and P BSM ALS low soil moisture storage and CBB |
| Technology transfer | Lack of seed low N and P lack of impact assessments lack of inputs bruchids BSM rust and poor crop management |

## Actıvıty 1 5 Refine characterızatıon of bean growıng envıronments usıng bıophysıcal and socıo economıc data

## Achıevements

- The Afrıcan bean database ıncludıng data on 57 varıables for 96 bean productıon areas was revısed and analyzed the database ıs ready for dıstrıbutıon to GIS practıtıoners and a draft of an atlas has been submıtted to publıcatıon

- Informatıon on the dıstrıbutıon of bean seed tvpes has been analyzed and publıshed wıth the expectatıon that ıt wıll better enable breeders to target new varıetıes

- Separate cultıvatıon of beans by men and women farmers has ımplıcatıons for food securıty varıetal choıce and the ıntensıty of productıon

- Among Ugandan farmers the consumptıon of beans fluctuates ın accordance wıth ıts avaılabılıty and that of other foods

- Whıle bean stem maggot ıs recognızed across Afrıca as the most ımportant maın season pest of bean surveys ın Malawı have shown that aphıds are more challengıng to the wınter crop and that farmers have less knowledge of potentıal control measures for these pre harvest pests than for bruchıds ın stored beans whıch are therefore better controlled

*The bean database and atlas for Afrıca*

**Contrıbutors** **C A Eledu C Wortmann**
**Sponsors** **CIDA SDC**

The bean database for Afrıca was updated and ınformatıon for 57 varıables and 96 bean productıon for sub Saharan Afrıca was further analyzed The major croppıng systems for bean productıon are the maıze bean ıntercrop and sole crop Calıma and red seed types of varyıng sızes are the maın seed types produced (Table 4) but other types are wıdespread at lower ıntensıty or are very ımportant locally The ımportance of women ın bean productıon ıs apparent (Map 1) The maın constraınts to bean productıon were determıned to be low soıl N and P angular leaf spot anthracnose and bean stem maggot (Table 5) water defıcıts are also of major ımportance The ımportance of root rots contınues to ıncrease and varıatıon ın theır ımportance can be largely explaıned by varıatıons ın populatıon densıty (PD) and ıntensıty of bean productıon (IBP)

Root rot ımportance = 1 62 + 0 000944 * PD + 0 090 * IBP $R^2$ = 0 53

Alternative production research strategies are proposed for areas considered to be of high versus low potential for bean production For high potential areas emphasis should be on improved management and efficiency of use of soil N and P and IPM or resistance to major diseases (e g angular leaf spot anthracnose and root rots) and bean stem maggot For low potential areas severely constrained by water deficits or the low pH complex emphasis should be on improved management of and tolerance to water deficits or the low pH complex IPM or genetic improvement for management of bean stem maggot angular leaf spot and locally important insect pests and diseases

Table 4 Estimated area ( 000 ha) sown annually to nine categories of bean seed types

| Seed category | Eastern Africa | Southern Africa |
|---|---|---|
| Calima | 650 | 90 |
| Red Small and medium | 510 | 160 |
| Red large and kidney | 230 | 120 |
| Yellow and tan | 290 | 90 |
| Cream | 240 | 120 |
| Navy | 190 | 120 |
| White large and medium | 150 | 90 |
| Purple | 150 | 120 |
| Black | 100 | 30 |

Table 5 Constraints to bean production in sub Saharan Africa ranked in descending order of importance ( 000 t yr $^{-1}$)

| Constraint | Sub Saharan Africa | Eastern Africa | Southern Africa |
|---|---|---|---|
| N deficiency | 389 9 | 26[illegible] 6 | 125 2 |
| Angular leaf spot | 384 2 | 281 3 | 93 5 |
| P deficiency | 355 9 | 234 2 | 120 4 |
| Anthracnose | 328 0 | 247 4 | 69 8 |
| Bean stem maggot | 297 1 | 194 4 | 96 4 |
| Bruchid | 245 6 | 163 0 | 77 6 |
| Root rot | 221 1 | 179 8 | [illegible]1 0 |
| Common bacterial blight | 220 4 | 145 9 | 69 8 |
| Exchangeable bases | 220 0 | 152 7 | 65 8 |
| Aphids | 196 9 | 136 3 | 58 9 |
| Rust | 191 4 | 118 7 | 72 4 |
| Bean common mosaic | 184 2 | 144 6 | 29 9 |
| Halo blight | 181 3 | 121 9 | 56 4 |
| Ascochyta blight | 169 2 | 129 4 | 34 2 |
| Al/Mn toxicity | 163 9 | 97 5 | 60 3 |
| Water deficit mid season | 158 0 | 119 8 | 34 7 |
| Water deficit late | 144 3 | 100 4 | 42 3 |
| Helicoverpa | 135 5 | 90 6 | 41 6 |
| Ootheca | 116 4 | 76 0 | 35 8 |
| Floury leaf spot | 113 7 | 89 7 | 14 5 |
| Maruca | 112 6 | 74 9 | 35 3 |
| Clavigralla | 102 7 | 64 9 | 36 0 |
| Water deficit early | 93 7 | 71 0 | 17 6 |
| Thrips | 87 0 | 55 2 | 29 4 |
| Fusarium wilt | 74 2 | 56 9 | 13 7 |
| Web blight | 59 5 | 27 4 | 34 1 |
| White mold | 54 4 | 39 2 | 11 7 |
| Charcoal rot | 53 2 | 38 6 | 10 1 |
| Scab | 52 9 | 38 6 | 7 6 |

Estimates assume that most commercial varieties have a yield potential of 3000 kg / ha that losses associated with high moderate and low ratings are 200 100 and 25 kg/ha and that yield potential with intercropping is reduced by 60%

*Analyses of gender issues in bean production*

**Contributors** **S David and S Kasozi**
**Sponsors** **CIDA and SDC**

Surveys conducted between 1995 1997 in 4 villages in Nabongo Parish Mbale District Uganda among female and male bean farmers and selected households show an emerging trend in the commercializing bean growing environments of Eastern Africa While most farm families surveyed cultivate beans on household plots personal plots belonging to either the wife or husband or both were found in 28 35% of cases

The motive for women s personal plots is to provide income (95%) and food for the family (70%) whereas men mainly grow beans as a cash crop Wives plots contributed the bulk of beans consumed by the household in a significant number of cases 65% in one study and 18% in a second survey where the sample consisted equally of women in monogamous and polygynous marriages Men s personal plots were the principal source of beans in only 5% of households interviewed in two surveys The majority of men who grew beans in 1994a used less than 20% of their harvest (55%) or none (9%) to feed their households whereas half of the women who harvested beans from personal plots sold none

While the size of men s and women s personal plots are nearly equal in season B men on average plant a greater number of plots of a larger size in the main growing season due to their better access to labor land and time (Table 6) Men also plant fewer varieties than women and concentrate on commercial seed types (*K20* and *Kanyebwa*) while women sow varieties both for home consumption and sale (*K20 Kanyebwa* and *White Haricot*) While on average men make more money from independent bean production women s smaller earnings appear to contribute more to daily household subsistence food and household necessities (40%) medical expenses (30%) clothes school related expenses and personal items (20% each) Future questions that need to be investigated in Uganda and elsewhere include what are the implications of introducing high yielding bean cultivars for women s autonomous bean production? In a situation where beans are grown on both household and personal plots who benefits from the yield advantage of improved cultivars? How can bean researchers and seed suppliers effectively respond to the needs of independent female producers?

Table 6 Characteristics of independent bean production by women and men farmers in Mbale District Uganda

| | Season | Women (N=20) | Men (N=11) |
|---|---|---|---|
| Mean number of plots | A | 1 5 | 2 6 |
| | B | 1 0 | 1 0 |
| Mean number of varieties sown | A | 1 8 | 1 2 |
| | B | 1 8 | 1 1 |
| Mean quantities planted (kg) | A | 15 7 | 21 0 |
| | B | 15 0 | 15 0 |
| Mean area planted (acres) | A | 0 5 | 0 7 |
| | B | 0 5 | 0 5 |
| Mean income | A | $15 | $50 |
| | B | $12 | $11 |

***Basline survey on bean consumption patterns***

**Contributors** **S David and S Kasozi**
**Sponsors** **CIDA and SDC**

A second baseline survey on food intake in sentinel impact sites in Mbale (Nabongo Parish) and Mukono (Lugala Parish) Districts of Uganda provided data on consumption patterns during a mid season period (September 1996) The first round of the food intake survey conducted in June 1995 provided data on consumption during the immediate post harvest period Most Ugandan farmers experience severe food shortages before harvest i e between April and June and November December

As Table 7 shows beans constitute an important relish in both study sites although they play a more dominant role in the Nabongo diet The availability of fish in Lugala means less dependency on beans as a source of protein Low bean consumption in Nabongo in September reflects a shortage among some households and in others the availability of substitutes such as groundnuts and vegetables The strategy among the latter households is to store beans at that time in anticipation of the period of food shortage starting in November when other relishes are scarce Impact assessment studies will determine whether the frequency and amount of beans consumed especially during periods of food shortage increases with the introduction of higher yielding cultivars

Table 7 Relishes consumed by households in Nabongo and Lugala Parishes Uganda (mean number of meals per week)

| | Nabongo | | Lugala | |
|---|---|---|---|---|
| | June (N=80) | September (N=40) | June (N=78) | September (N=48) |
| Beans | 7 6 | 2 9 | 3 5 | 3 1 |
| Meat/Chicken | 1 3 | 1 5 | 0 5 | 0 6 |
| Fish | 0 8 | 0 6 | 4 1 | 3 6 |
| Vegetables | 3 8 | 7 5 | 1 3 | 3 6 |
| Groundnuts | 0 8 | 4 4 | 5 8 | 3 2 |

***Diagnostic studies on bean insect pests in Malawi***

**Contributor** **Sally Ross (DFID/DARTS)**
**Sponsors** **DFID and GoM**

Progress continued to be made with respect to improving the knowledge of bean pests in Malawi in southern Africa to complement field information learned earlier in Eastern African countries that has proven useful in setting reserch priorities there The key pests and their population dynamics were established for the winter (dry season) crop grown on residual moisture Aphids (*Aphis fabae*) leafhoppers (*Empoasca* spp ) and whiteflies (*Bemisia tabaci*) were most prevalent with aphid and whitefly attack varying according to planting date In a survey of their perceptions in four ecologically distinct production areas farmers identified bean stem maggot (BSM) (*Ophiomyia* spp ) bean foliage beetle (*Ootheca* spp ) and aphids as their primary pre harvest pests While BSM is the most significant pest of summer season rain grown production aphids present a heavy challenge to winter beans produced on residual moisture These pre harvest pests remain largely uncontrolled due to lack of knowledge of potential control measures and financial constraints The majority of farmers reported that bean bruchids which caused serious damage in their stores were better controlled as knowledge of post harvest cultural control practices is greater

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

## Activity 2 1 Targeting of bean germplasm

### Achievements

- The DSSAT Drybean model was used to test bean ideotypes early maturing varieties gave most yield and stability in those rainfall zones more stressed by water deficits

- Characterization of pathogenic diversity in angular leaf spot (ALS) isolates identified in addition to the Andean and Mesoamerican groups an Andean sub group of 12 races that attack a few Mesoamerican varieties

- Mixed occurrence of the main ALS pathogen groups and detection of the Andean sub group are significant distinguishing features of pathogen diversity between Latin America and Africa diversity information is being used to develop race maps for Africa

***Water deficit stress in bean in eastern and southern Africa***

**Contributor Dr Belay Simane (AUA)**
**Collaborator C Wortmann**
**Sponsors CIDA SDC**

Bean productivity is much constrained by water deficits in many production areas in eastern and southern Africa The DSSAT 3 Drybean model was used to analyze the effects of water deficits on bean using genetic coefficients of four cultivars including an early determinate type an early intermediate and late maturity indeterminate bush types More than 2300 simulations were run using meteorological data from 19 locations The late maturing ideotype (*Carioca*) gave highest yield in less stressful environments but its yield was the least stable (Table 8) In environments with more frequent and severe water deficits early maturing ideotypes had highest mean yield and their yield was most stable in all environments Stress was most severe and frequent in the later stages of growth stress had the greatest effect on yield during podfill > early reproductive > vegetative stage

Table 8 Mean yields and yield reductions (and SE s) due to water deficits for four bean ideotypes in five agroecological zones of eastern and southern Africa

| Ideotype | Yield kg ha$^{-1}$ | S D for yield | % yield reduction | S D for reduction |
|---|---|---|---|---|
| Moderately low stress, low latitude n = 580 | | | | |
| Seafarer | 2753 | 680 | 14 2 | 21 2 |
| Rabia de Gato | 2650 | 709 | 16 6 | 22 5 |
| Kilymukwe | 3020 | 956 | 18 2 | 25 4 |
| Carioca | 5359 | 1059 | 20 6 | 24 7 |
| Moderate stress, low latitude, n = 744 | | | | |
| Seafarer | 2259 | 894 | 29 9 | 27 6 |
| Rabia de Gato | 2307 | 875 | 27 3 | 27 5 |
| Kilymukwe | 2235 | 1185 | 35 9 | 33 7 |
| Carioca | 2450 | 1534 | 57 8 | 33 6 |
| Severe and frequent stress, low latitude, n = 408 | | | | |
| Seafarer | 1899 | 1079 | 42 6 | 32 7 |
| Rabia de Gato | 1925 | 1115 | 41 6 | 33 8 |
| Kilymukwe | 1778 | 1196 | 51 7 | 32 4 |
| Carioca | 1743 | 1323 | 58 0 | 31 8 |
| Moderate stress, mid latitude, n = 520 | | | | |
| Seafarer | 2494 | 967 | 28 2 | 27 5 |
| Rabia de Gato | 2469 | 1001 | 30 6 | 27 1 |
| Kilymukwe | 2594 | 1142 | 30 4 | 29 5 |
| Carioca | 2704 | 1292 | 35 0 | 29 7 |
| Severe and frequent stress, mid latitude, n = 64 | | | | |
| Seafarer | 1949 | 1153 | 45 2 | 33 6 |
| Rabia de Gato | 1828 | 1047 | 47 2 | 30 3 |
| Kilymukwe | 1921 | 1281 | 52 2 | 32 0 |
| Carioca | 1999 | 1385 | 53 0 | 32 6 |

*Pathogen diversity in Phaeoisariopsis griseola in Africa*

**Collaborators** **R Buruchara and Bua Bosco Lucia Afanador and Carlos Jara (IP 1)**
**Dr Fina Opio (NARO) Ms Kijana Ruhebuza (INERA)**
**Dr Charles Kisyombe (DARTS)**
**Sponsors** **CIDA SDC USAID and national programs**

Recent studies on a small number of isolates have shown that pathogen diversity of *P griseola* (ALS) in Africa closely corresponds to that of Latin America two pathogen groups corresponding to the Andean and Mesoamerican genepools of common bean that are in turn associated with the crop s two distinctive centers of diversity In Africa the Andean bean genepool has been the more preferred but the two are commonly grown together The current studies support national and regional breeding strategies for resistance against ALS through determining the extent of pathogen diversity in Africa its distribution how it relates to common bean genotypes and its likely evolution within Africa

A total of 168 isolates from 6 countries were characterized this year using Random Amplified Polymorphic DNAs (RAPDs) analysis while 90 were characterized using virulence on the set of 12 ALS differential cultivars In RAPDs analysis 12 primers (OPA 01 OPA 02 OPA 03 OPA 04 OPA 10 OPA 11 OPA 18 OPC 01 OPC 02 OPE 03 OPF 01 OPH 08) which gave good degrees of polymorphism were used Not only were more isolates characterized this year but isolates from Ethiopia Kenya and Zambia were characterized for the fist time

Isolates could be categorized with either method in the two groups corresponding to the Andean and Mesoamerican pathogen genepools On the basis of virulence on differential cultivars 37 races were identified from 90 isolates indicating wide pathogen diversity Each race however was restricted to a few areas 7ͻ% of races were identified in only one country 18 9% in two and no race occurred more than 4 countries (Table 9) Comparison of virulence and RAPDs in characterizing *P griseola* was made on 45 isolates using data matrixes for the presence or absence of bands (in RAPDs) and compatible or incompatible reactions Dendrograms were created using the TREE program of NTSYS pc (version 1 80) The 45 isolates could be grouped into Andean (27) and Mesoamerican (18) groups in exactly the same way (in identity and in number) using either method

However when using virulence a novel sub group of Andean isolates was identified with isolates capable of producing compatible reactions on one but not more than three Mesoamerican differential cultivars This confirms preliminary results obtained last year Nineteen isolates out of 90 characterized by virulence belonged to this class and came from Ethiopia, Rwanda and Uganda (Table 9) Occurrences of this class seem unique to Africa indicating a major difference in pathogen diversity of *P griseola* with Latin America Equally important is the large number of races (12) represented and their occurrence in 3 countries It is suggested that this class represents a divergent form of co evolution with the bean host from that observed in Latin America Being primarily Andean (by virulence and RAPDs) the pathogenicity of the isolates to Mesoamerican genotypes may have evolved in Africa probably due to growing together of the two bean genepools Both Andean and Mesoamerican groups of isolates have been found (combining data from the last two years) from all countries and in some cases at the same site All isolates characterized this year from Malawi and Kenya belonged to the Mesoamerican pathogen group probably because these isolates were obtained only from small seeded cultivars This again emphasizes the relationship between the host and pathogen genepools rather than a mere reflection of existing diversity

Table 9 Pathogen diversity of 90 *Phaeoisariopis griseola* isolates from 6 African countries characterized by virulence on the set of 12 ALS differentials

| Pathogen genepool | Race | Number of isolates corresponding to a specific race | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Uganda | Rwanda | Ethiopia | Malawi | Kenya | Zambia | Total |
| Andean | 14-0 | 2 | 3 | | | | 1 | 6 |
| | 30-0 | | 1 | | | | 5 | 6 |
| | 31-0 | | | | | | 1 | 1 |
| | 47-0 | 1 | | | | | | 1 |
| | 62 0 | | | 1 | | | | 1 |
| | 63-0 | 2 | | | | | | 2 |
| Sub total | 6 | | | | | | | 17 |
| Andean sub-class (Novel) | 63 1 | 2 | | | | | | 2 |
| | 63 17 | 1 | | | | | | 1 |
| | 56 32 | | | 1 | | | | 1 |
| | 57 32 | | | 1 | | | | 1 |
| | 59 32 | | | 2 | | | | 2 |
| | 63 32 | | | 4 | | | | 4 |
| | 62 33 | | 1 | | | | | 1 |
| | 63 53 | | 1 | 1 | | | | 2 |
| | 31 56 | 1 | | | | | | 1 |
| | 59 56 | 1 | | | | | | 1 |
| | 63 36 | | | 1 | | | | 1 |
| | 63 37 | 1 | | 1 | | | | 2 |
| Sub total | 12 | | | | | | | 19 |
| Mesoamerican | 3 7 | | | | | | | 1 |
| | 7 7 | | 1 | | | | | 1 |
| | 21 7 | | 1 | | | | | 1 |
| | 23 7 | | 1 | | | | | 1 |
| | 31 7 | 2 | 1 | | | | 1 | 4 |
| | 3 39 | | | | | 1 | | 1 |
| | 31 39 | 5 | 1 | | 4 | 6 | | 16 |
| | 21 39 | | | | 3 | | | 3 |
| | 61 39 | 1 | | | 2 | | | 3 |
| | 63 39 | 1 | | | 4 | | | 5 |
| | 31-47 | 1 | | | | | | 1 |
| | 31 23 | | | | 1 | | | 1 |
| | 63-47 | | | | 1 | | 1 | 2 |
| | 59 47 | 1 | | | | | | 1 |
| | 31-63 | 1 | | | | | | 1 |
| | 59 55 | 1 | | | | | | 1 |
| | 31 55 | | | | | 5 | | 5 |
| | 63 55 | 2 | | 1 | | | | 3 |
| | 63-63 | 3 | | | | | | 3 |
| Sub total | 19 | | | | | | | 54 |
| Total | 37 | | | | | | | 90 |

Categories of genepool determined on the basis of virulence on the set of 12 Andean (6) and Mesoamerican (6) differential cultivars Novel class are Andean isolates which attack one or up to 3 Mesoamerican differentials Race denomination is obtained by adding the binary values of susceptible Andean and Mesoamerican differentials the two values are combined but distinguished by a hyphen

# Actıvıty 2 2 Germplasm to address Afrıcan productıon constraınts

## Achıevements

- CIAT and natıonal bean materıals were ıdentıfied wıth resıstance to both Andean and Mesoamerıcan pathogen groups of angular leaf spot (ALS) the value of usıng characterızed dıversıty selectıvely ın germplasm evaluatıons was confirmed

- Four medıum/large seeded Andean and 24 small seeded Mesoamerıcan lınes exhıbıted good tolerance to both Andean and Mesoamerıcan local straıns of ALS some of these lınes are also resıstant to BCMNV and outyıelded released varıetıes

- One hundred and fourteen lınes combıned resıstance to the vırus dıseases BCMV and BCMNV wıth good yıeld potentıal and several large seeded BCMV/BCMNV resıstant lınes wıth export potentıal entered pre release multıplıcatıon wıth Uganda Seeds Scheme

- Eıght lınes were ıdentıfied as resıstant to common bacterıal blıght (CBB) five of whıch outyıelded MCM 5001 46 lınes had good tolerance to CBB and some were also resıstant to BCMNV

- Well adapted lınes have been ıdentıfied wıth resıstance or good tolerance to two or three of the ımportant bıotıc constraınts BCMNV ALS and CBB

- A total of 748 entrıes from CIAT and natıonal sources were evaluated for resıstance to Pythıum and Rhızoctonıa root rots none was resıstant but 122 gave an ıntermedıate reactıon Promısıng materıals were re evaluated and 39 were dıstrıbuted to partners

- Sıxty four entrıes were confirmed as hıghly resıstant sources agaınst anthracnose and 24 clımbıng bean entrıes were selected for regıonal dıstrıbutıon

- Sıgnıficant varıetal dıfferences ın tolerance to BSM were observed ın Malawı and three recently released varıetıes showed hıgh levels of tolerance

- Two bean varıetıes consıstently showed tolerance ın Malawı to both low P and low N constraınts

- A wıde range of germplasm was evaluated on statıon and on farm ın Malawı and several promısıng lınes were ıdentıfied

Notable ımprovements ın yield *per se* over local cultıvars/landraces have been recorded by many of the large number of CIAT derived lines introduced and released by NARS in Africa over the last ten years Recent introductions particularly to Eastern Africa, have not maintained the same momentum in yield improvement We are now emphasizing the development of well adapted lines with single and in particular multiple resistance against the principal biotic and abiotic constraints that can be used by NARS to improve the yield stability of new cultivars released to farmers In this section we report on the identification of sources of resistance to important disease insect and soil fertility constraints and on the improvement of breeding materials for single and multiple resistances along with yield

***Use of Andean and Mesoamerican race groups of P griseola in screening germplasm for angular leaf spot resistance***

**Contributors R Buruchara B Bosco**
**Sponsors CIDA SDC**

Based on results obtained in pathogen diversity studies of *P griseola* in Uganda isolates representing the Andean and Mesoamerican genepool were selected and used to evaluate germplasm and breeders materials against ALS under screenhouse conditions Three Andean and 4 Mesoamerican isolates were selected for their complementarity in pathogenicity on the 12 ALS differentials if mixed together the Andean isolates attack the 6 Andean differentials while the Mesoamerican isolates attack all 6 Mesoamerican differentials Some entries gave susceptible reactions to Mesoamerican isolates while being resistant to Andean and vice versa (Table 10) Clear examples emerged where entries susceptible to Mesoamerican isolates were small seeded genotypes but those resistant to the same (Mesoamerican isolates) were large seeded genotypes and vice versa

Entries previously evaluated under field conditions and identified to be resistant to ALS were re evaluated in the screenhouse against the two pathogen diversity groups inoculated separately Of the 33 IBN 94 and 27 SOH Rwanda entries previously screened and rated as resistant only 13 IBN 94 and 20 SOH Rwanda were resistant to both isolates In the VIFURE nursery (ex CIAT) of 147 potential sources of resistance to different constraints 13 entries had a resistant reaction ($\leq$ 3) to both isolates 36 were resistant to Andean isolates 25 were resistant to the Mesoamerican isolates while most were susceptible to both pathogen groups These results demonstrate the importance and need to use selectively the known pathogen diversity of *P griseola* in evaluating germplasm or breeding materials The challenge however is how to ensure that appropriate diversity is used

Table 10 Reaction of selected large and small seeded lines to inoculation with a mixture of Andean (3) and Mesoamerican (4) isolates of *Phaeoisariopsis griseola* under screenhouse conditions Kawanda 1997

| Entry | Seed Size | Nursery | Disease severity | |
|---|---|---|---|---|
| | | | Andean Isolates | Mesoamerican Isolates[y] |
| AB 136 | S | VIFURE | 3 | 9 |
| BAT 304 | S | VIFURE | 4 | 9 |
| Beldakmi RR 6 | S | VIFURE | 4 | 9 |
| Berly | S | VIFURE | 3 | 9 |
| Carioca | S | VIFURE | 3 | 9 |
| Catrachita | S | VIFURE | 4 | 9 |
| DOR 309 | S | VIFURE | 4 | 8 |
| Bola 60 Dias | L | VIFURE | 9 | 3 |
| PVA 800A | L | VIFURE | 9 | 3 |
| G 16140 | L | VIFURE | 7 | 3 |
| UBR(83)4/20 | L | Advanced Lines | 9 | 3 5 |
| UBR(93)4/30 | L | Advanced Lines | 7 5 | 4 |
| DB86/16 | L | Advanced Lines | 9 | 4 |
| UBR(93)4/25 | L | Advanced Lines | 7 5 | 4 5 |
| AFR 706 | L | Advanced Lines | 9 | 3 |
| MCM 5001 (Check) | S | Released variety | 9 | 9 |
| Kanyebwa (Check) | L | Released variety | 8 | 9 |

Based on a CIAT scale of 1 to 9

Entries Some of IBN and VIFURE entries screened

Mixture of 3 Andean isolates each represented in the inoculum at concentration of $2 \times 10^4$ conidia per ml

[y] Mixture of 4 Mesoamerican isolates each represented in the inoculum at a concentration of $2 \times 10^4$ conidia per ml

***Development of bush bean lines with resistance to African strains of angular leaf spot (ALS)***

**Contributor** **H Gridley**
**Collaborator** **R. Buruchara**
**Sponsors** **CIDA SDC**

Prior to 1996b we had conducted field screening for ALS resistance amongst lines introduced from CIAT Cali in the core collection and IBN 94 and in BCMNV resistant lines bred in Uganda However as both Andean and Mesoamerican ALS strains are endemic in the field (see section 2 1 above) the lines selected previously were inoculated in the screenhouse with known strains of ALS (derived from single spore isolates) using a randomized block design with two replicates to determine the exact nature of the recorded field resistance or tolerance

In a first such screening 32 selected medium/large seeded lines were markedly more susceptible to the mixture of Andean strains (Table 11) No resistance was detected to either mixture of strains but 11 and 21 lines were tolerant to the Andean and Mesoamerican strains respectively (Table 11) Four lines were notably superior to both strains viz UBR(93)1/12 UBR(93)4/22 UBR(92)4/29 and AFR 707 (Table 12) all except the second line outyielded CAL 96 although not significantly ($\leq P$ 0 05) and the lines coded UBR are resistant to BCMNV

In a second such screening 43 small seeded Mesoamerican lines which had shown resistance in the field were notably more resistant than the 32 Andean lines to the both sets of strains and were marginally more susceptible to the Mesoamerican strains This trend was emphasized with a greater frequency of lines resistant to the Andean strain (39) compared to 26 for the Mesoamerican strains We identified 24 exceptional lines with combined resistance to both sets of strains 21 of these lines outyielded MCM 5001 five significantly and the 17 coded UBR are resistant to BCMNV (Table 12)

We have successfully identified resistance to the Mesoamerican strains in Mesoamerican lines but so far found tolerance to Andean strains only amongst Andean lines (Table 11) Failure to identify the latter may necessitate transferring the Andean resistance in Mesoamerican lines to Andean lines via intergene pool crosses this has been initiated

Table 11 ALS ratings from artificial inoculation in the screenhouse and yield (% CAL 96[3]) at one site in 96b of 52 medium or large seeded bush lines (≥30g/100 seeds) in Uganda

| | ALS ratings | | | | ALS ratings | | |
|---|---|---|---|---|---|---|---|
| Line code[1] | And | Meso | Yield[3] | Line code[1] | And | Meso | Yield[3] |
| UBR(93)1/2 | 4 0 | 3 5 | 107 | DB 215/21614 | 4 0 | 5 5 | 43 |
| 4/17 | 9 0 | 4 5 | 142 | 15 | 9 0 | 5 0 | 43 |
| 20 | 8 5 | 3 5 | 92 | UBR(95)6 | 8 0 | 4 5 | 84 |
| 22 | 4 5 | 4 5 | 84 | 7 | 9 0 | 5 5 | 69 |
| 26 | 9 0 | 5 0 | 113 | 9 | 9 0 | 4 5 | 102 |
| 30 | 9 0 | 4 0 | 156* | DB 201/76/7 | 8 0 | 4 5 | 76 |
| 33 | 8 0 | 4 5 | 156 | 1 | 7 0 | 4 0 | 90 |
| 1/4 | 7 0 | 4 0 | 101 | 86/16 | 7 5 | 4 0 | 76 |
| 4/4 | 5 5 | 5 0 | 137 | 17 | 5 5 | 4 0 | 81 |
| 5 | 6 0 | 4 5 | 102 | DB 202/ 5 | 5 5 | 4 0 | nt |
| 6 | 9 0 | 4 0 | 115 | 200/ 1 | 6 0 | 5 5 | nt |
| 9 | 9 0 | 4 5 | 119 | 11 | 7 0 | 5 5 | nt |
| 31 | 7 0 | 5 0 | 111 | UBR(92)4/29 | 4 0 | 3 5 | 127 |
| 1/15 | 5 5 | 5 5 | 82 | AFR 707 | 4 5 | 4 0 | 102 |
| 4/18 | 7 5 | 5 5 | 83 | | | | |
| 25 | 9 0 | 4 5 | 74 | Mean | 7 4 | 4 6 | |
| 34 | 9 0 | 6 5 | 156 | | | | |
| 36 | 9 0 | 5 0 | 45 | SED | 0 72 | 1 05 | |

[1] Lines with UBR code resistant to Bean Common Mosaic Necrosis Virus
[2] ALS ratings on a scale of 1 9 where 1 3 = resistant 4 6 = tolerant 7 9 = susceptible
Meso/And ratings from reaction to local Mesoamerican and Andean strains respectively
[3] Yield data as a percentage of CAL 96 taken as 100 in trials evaluating lines selected for ALS tolerance
* line with a significant (P≤0 05) yield increase over CAL 96
No yield data for these lines

Table 12 ALS ratings from artificial inoculation in the screenhouse and yield (% of MCM 5001 ) at one site in 96b of 43 small seeded bush lines (<29g/100 seeds) in Uganda

| | ALS ratings | | | | ALS ratings | | |
|---|---|---|---|---|---|---|---|
| Line code[1] | And | Meso | Yield[3] | Line code[1] | And | Meso | Yield[3] |
| G 12800 | 3 0 | 3 0 | 110 | UBR(92)13/ 4 | 3 0 | 1 0 | 142 |
| G 4830 | 2 5 | 1 5 | 145 | 11 | 2 0 | 1 5 | 162* |
| G 3474 | 4 0 | 3 0 | 151 | 13 | 2 0 | 1 0 | 102 |
| FEB 181 | 2 5 | 2 0 | 110 | 18 | 1 5 | 1 0 | 110 |
| 184 | 2 0 | 2 5 | 172 | 22 | 2 5 | 1 0 | 122 |
| 199 | 2 0 | 2 5 | 147 | 23 | 2 5 | 1 0 | 175* |
| SEA 7 | 2 5 | 3 0 | 192 | 30 | 2 0 | 2 0 | 147 |
| DOR 725 | 4 0 | 5 5 | 105 | 32 | 2 5 | 2 5 | 145 |
| 849 | 5 0 | 5 5 | 165* | 33 | 2 5 | 1 5 | 165* |
| 629 | 4 0 | 3 0 | 120 | 40 | 2 5 | 2 5 | 175* |
| 640 | 4 0 | 3 0 | 127 | 25/ 3 | 2 0 | 2 5 | 102 |
| 644 | 5 5 | 3 0 | 172* | 4 | 2 0 | 2 5 | 127 |
| 660 | 4 5 | 3 5 | 127 | 11 | 1 0 | 2 0 | 87 |
| 664 | 4 0 | 3 5 | 135 | 13 | 3 0 | 2 5 | 117 |
| 682 | 5 0 | 6 0 | 137 | FEB 181 | 2 5 | 2 0 | 110 |
| SEA 13 | 5 0 | 2 0 | 147 | 199 | 2 0 | 2 5 | 147 |
| FEB 184 | 2 0 | 1 5 | 122 | DOR 745 | 4 5 | 3 0 | 193* |
| DOR 633 | 4 5 | 3 5 | 176* | 640 | 4 0 | 3 0 | 127 |
| 747 | 5 0 | 3 0 | 184* | 644 | 3 5 | 4 0 | 172* |
| UBR(93)43/1 | 5 5 | 1 5 | 102 | | | | |
| 8 | 5 5 | 6 5 | 112 | | | | |
| 12 | 1 5 | 2 0 | 80 | Mean | 3 5 | 2 8 | |
| UBR(92)9 | 3 5 | 2 5 | 110 | | | | |
| UBR(92)11 | 2 0 | 2 5 | 82 | SED | 1 07 | 1 13 | |

1 Lines with UBR code resistant to Bean Common Mosaic Necrosis Virus

2 ALS ratings on a scale of 1 9 where 1 3 = resistant 4 6 = tolerant 7 9 = susceptible
Meso/Ad ratings from reaction to local Mesoamerican and Andean strains respectively

3 Yield data as a percentage of MCM 5001 taken as 100 in trials evaluating lines selected for ALS tolerance
* line with a significant ($P \leq 0.05$) yield increase over MCM 5001

***Development of lines with resistance to bean common mosaic virus (BCMV) and bean common mosaic necrosis virus (BCMNV)***

**Contributor** **H Gridley**
**Collaborator** **Dr Theresa Sengooba (NARO)**
**Sponsors** **CIDA SDC NARO**

Recently the necrotic strains (NL3 NL5 and NL8) of BCMV that cause black root or systemic necrosis in plants carrying the dominant I gene have been recognized as a new virus termed bean common mosaic necrosis virus (BCMNV) The others or soft strains that only induce mosaic symptoms in non I gene plants retain the original name of bean common mosaic virus (BCMV) As we have been incorporating recessive resistance genes into lines that confer resistance to both viruses reference here to BCMNV resistance denotes resistance to both

This year we yield tested 161 BCMNV resistant bush lines selected from segregating populations with a range of seed types but with increased attention to those with desirable market and export potential i e large and medium seeded calima sugar and red types Although 114 (71%) lines had yields equivalent to the controls significant ($P \leq 0\ 05$) increases were limited to three lines (Table 13) Two of these were large seeded lines in the PBR 97a significantly outyielding CAL 96 by 67% and 98% in this one environment test

Eleven BCMNV resistant large seeded bush lines comprising four Calima two Canadian Wonder and five Sugar types were identified with a consistently superior yield to CAL 96 These have been passed simultaneously to the Ugandan National Bean Programme for yield evaluation in advanced yield trials and the Ugandan Seeds Scheme for pre release multiplication The five sugar lines were compounded into a multiline which is to be recommended for release in 1998

Table 13 Mean yield over one or more environments of bush lines with resistance to Bean Common Mosaic Virus (BCMNV) from 96b to 97a in Uganda

| Trial[1] | Number of lines | Seed size[2] | No environments | Yield performance[3] | | | |
|---|---|---|---|---|---|---|---|
| | | | | Yield (kg/ha) | | Number of lines | |
| | | | | Range lines | Control | = control | >s control |
| ABR 96B | 37 | Medium/ Large | 3 | 599 955<br>SED 87 4 | 888 | 28 | 0 |
| PBR 96bB/ IBR 97a | 18 | Medium/ Large | 4 | 578 1280<br>SED 96 5 | 950 | 11 | 0 |
| PBR 96b | 31 | Small | 1 | 475 1755<br>SED 108 5 | 1350 | 12 | 1<br>(16%) |
| IBR 97a | 16 | Small | 1 | 777 1577<br>SED 192 0 | 1155 | 15 | 0 |
| PBR 97a | 47 | Large | 1 | 95 1507 | 761 | 46 | 2<br>(67% 98%) |
| | 12 | Small | 1 | 322 1431<br>SED 220 0 | 1586 | 2 | 0 |
| Total | 161 | | | | | 114 | 3 |

1 PBR/IBR/ABR preliminary intermediate and advanced yield trials respectively evaluating BCMNV resistant lines
2 Seed size small ≤29g/100 seeds medium/large ≥30g/100 seeds
3 Controls CAL 96 for medium/large seeded and MCM 5001 for small seeded lines
= >s respectively number of lines with yields not differing significantly (P≤0 05) from the control and with significant (P≤0 05) yield increase over the control
SED standard error of a difference

***Development of bush bean lines with resistance to common bacterial blight (CBB)***

**Contributor** **H Gridley**
**Sponsors** **CIDA SDC NARO**

The identification of good sources of CBB resistance has proved elusive Accordingly prior to 1996b we conducted field screening for CBB resistance amongst lines introduced from CIAT Cali in the core collection and the IBN 94 and noted lines amongst those bred for BCMNV resistance in Uganda with below average ratings for CBB tolerance in the field Sixty four lines with superior CBB ratings from these sources were selected for artificial inoculation (using a randomized block design with two replicates) in the screenhouse

Only 11% of the lines were susceptible (Table 14) proving that the field screening had been effective in identifying resistant and tolerant lines Three lines UBR(92)13/4 UBR(92)24/14 and DB 190/73 in the more tolerant group II are also resistant to BCMNV Of the eight resistant lines two yielded less than MCM 5001 six outyielded this cultivar one (FEB 197) doing so significantly (P≤ 0 05) (Table 14)

Table 14 CBB ratings from artificial inoculation of 64 bush lines grouped into four resistance classes and line codes CBB ratings yield (% MCM 5001[2]) at one site in 96b and seed characters of eight resistant lines in Uganda

Summary of CBB ratings[1] for all 64 lines

| Resistance Class | Rating range | Frequency of lines (%) |
|---|---|---|
| Susceptible | (≥7 0 9 0) | 7 (11%) |
| Tolerant I | (≥5 1 ≤6 9) | 11 (17%) |
| Tolerant II | (≥3 1 ≤5 0) | 38 (59%) |
| Resistant | (1 0 ≤3 0) | 8 (13%) |

Eight Resistant Lines

| Line code | CBB rating | Yield[2] | Seed characters: Weight[3] | Seed characters: Colour/type |
|---|---|---|---|---|
| AND 1070 | 2 5 | | 21 | Cream |
| FEB 185 | 3 0 | 121 | 21 | Carioca |
| DOR 745 | 5 0 | 112 | 22 | Red |
| DOR 848 | 3 0 | 122 | 20 | Red |
| DOR 682 | [illegible] | 132 | 20 | Black |
| FEB 176 | 3 0 | 84 | 23 | Cream |
| SEA 5 | 1 5 | 104 | 22 | Cream |
| FEB 1[illegible]7 | 3 0 | 141 | 27 | Black |
| <u>Control</u> | | | | |
| Kanyebwa | 9 0 | nt | | |
| SED | 1 86 | | | |

1 CBB ratings on a scale of 1 9 where 1 3 = resistant 4 6 = tolerant 7 9 = susceptible

Yield data from trials evaluating lines selected for CBB tolerance and expressed as a percentage of MCM 5001 taken as 100

line with a significant (P≤0 05) yield increase over MCM 5001

nt Control cultivar not tested in yield trial

3 Weight of 100 seeds

*Development of bush bean lines with multiple disease resistance*

**Contributor** **H Gridley**
**Sponsors** **CIDA SDC NARO**

From compilation of the above data on screening for BCMNV ALS and CBB we have identified the following 28 lines as having resistance or good tolerance to two or three of these biotic constraints with none yielding significantly less than their appropriate control

ALS+CBB+BCMNV

UBR(92)13/4 a small brown seeded combined resistance to BCMNV with resistance to both ALS strains and good tolerance to CBB

ALS+CBB

five small seeded lines combined resistance to CBB with resistance and/or good tolerance to both ALS strains

ALS+BCMNV

- one medium seeded and two large seeded lines combined resistance or good tolerance to both ALS strains with BCMNV resistance
- 17 small seeded brown Carioca or white lines combined resistance to both strains of ALS with resistance to BCMNV

CBB+BCMNV

two lines combined good tolerance to CBB with resistance to BCMNV

All lines had yields not differing significantly from their appropriate small or large seeded control and a number showed significant yield increases over these controls in one or two seasons (Table 15) In much of the region large seeded beans are preferred therefore the multiple resistance so far identified in predominantly in smaller seeded lines needs to be incorporated into larger seeded beans with consumer acceptable seed characteristics

We have received seventy four lines with resistance to more than one disease from NARS in Ethiopia, Kenya and Rwanda These lines together with multiple resistant lines from the CIAT breeding program are being multiplied for distribution to interested NARS in early 1998

Table 15 CBB and ALS ratings from inoculation in the screenhouse and yield (% control[4]) of bush lines with varying seed sizes and resistance or superior tolerance to two or more biotic constraints in Uganda

| Disease Combinations[1] | Line code | Disease ratings[3] | | Yield as / control | | Seed characters | |
|---|---|---|---|---|---|---|---|
| | | CBB | ALS M/A | 96a | 96b | Weight | Colour/ type |
| ALS(A+M)/ CBB/BCMNV | UBR(92)13/4 | 4 0 | 3 0/1 0 | 159* | 142 | | Brown |
| ALS(A+M)/ CBB | FEB 181 | 2 5 | 2 5/2 0 | 79 | 110 | 24 | Carioca |
| | FEB 199 | 3 5 | 2 0/[illegible] 5 | 16[illegible]* | 147 | 20 | Carioca |
| | DOR [illegible]45 | 3 0 | 4 5/3 0 | 211 | 193* | 22 | Dark red |
| | DOR 640 | 3 5 | 4 0/5 0 | 176 | 127 | [illegible]0 | Black |
| | DOR 644 | [illegible] 5 | 3 5/4 0 | 159 | 17[illegible] | 20 | Black |
| ALS(A+M)/ BCMNV | UBR(93) 1/42 | 5 | 4 0/3 5 | | 197* | 31 | Calima |
| | UBR(93) 4/12 | | 4 5/4 5 | | 84 | 39 | Calima |
| | UBR(92) 4/29 | | 4 0/3 5 | | 122 | 42 | Calima |
| | 17 UBR small seeded lines[6] | | | | (see table 4[6]) | | Brown/Carioca/ White |
| CBB/BCMNV | DB 190/73 | 4 0 | | | 103 | 20 | White |
| | UBR(92)24/14 | 4 0 | | | 109 | 16 | Brown |

1 ALS(A+M)/CBB/BCMNV angular leaf spot (Andean + Mesoamerican strains) common bacterial blight and bean common mosaic necrosis virus respectively

2 Lines with UBR code resistant to Bean Common Mosaic Necrosis Virus

3 ALS and CBB ratings on a scale of 1 9 where 1 3 = resistant 4 6 = tolerant 7 9 = susceptible

ALS M/A ratings from a inoculation with local Mesoamerican and Andean strains respectively

Yield data from trials evaluating lines selected for ALS or CBB tolerance at one site (Kawanda) in one or two seasons expressed as a percentage of a control (taken as 100) if small seeded (≤29g/100 seeds) / of MCM 5001 if large seeded (>30g/100 seeds) / of CAL 96

* line with a significant (P≤0 05) yield increase over the appropriate control

5 Line not screened for the disease or not yield tested

6 Lines with a seed weight of ≤29g/100 seeds ALS ratings and yield in 96b given in table 4 the lines with seed types/colours of brown or Carioca or white

7 Weight of 100 seeds

### *Identification of new sources of resistance to Pythium and Rhizoctonia root rots*

**Contributor** **R Buruchara B Bosco**
**Sponsors** **CIDA SDC USAID NARO**

A total of 748 entries from the Core Collection (367) IBN 94 (3) VIFURE nursery (147) SOH Rwanda collection (145) and components of mixtures from south west Uganda (86) were evaluated for their reaction to Pythium and Rhizoctonia root rots Pythium is the most important root rot disease in the eastern Africa highlands Screening was based on artificial inoculations in wooden trays separately for *Pythium* spp and *Rhi octonia solani* pathogens

Despite the two soilborne pathogens often occurring together in nature evaluating against them separately gave better results None of the 748 entries gave a resistant reaction (≤ 3) About 12% 10% and 33% of the Core Collection VIFURE and SOH Rwanda germplasm respectively gave intermediate reactions (3 1 6 9) (Table 16) and some of these have performed well under field conditions Most entries were susceptible About 75% of entries rated as intermediate were small or medium seed types consistent with previous observations that very few large seed types have good levels of resistance That one third of SOH Rwanda materials so far evaluated gave an intermediate reaction may be related to the importance of root rots in Rwanda and the likelihood that selection for tolerance is occurring in local mixtures grown As few entries have good levels of resistance the increasing frequency and severity of root rots is likely in the long run to influence genetic composition and reduce its diversity

Table 16 Response of entries drawn from various nurseries to artificial inoculation with *Pythium* spp and *Rhi octonia solani* under screenhouse conditions Kawanda 1997

| | | Disease severity classes | | |
|---|---|---|---|---|
| Nursery | Entries | Resistant (≤ 3) | Intermediate (3 1 6 9) | Susceptible (7 9) |
| Core Collection | 367 | 0 | 43 | 324 |
| IBN | 3 | 0 | 3 | 0 |
| VIFURE | 147 | 0 | 14 | 133 |
| SOH | 145 | 0 | 49 | 96 |
| Local Mixtures (Uganda) | 86 (components) | 0 | 8 | 78 |
| Total | 748 | 0 | 117 | 631 |

*Identification of sources of resistance to anthracnose*

**Contributor** **R Buruchara**
**Collaborators** **Leontine Uwamariya Domitille Mukankubana and Augustine Musoni (ISAR) Tesfaye Beshir (IAR)**
**Sponsors** **CIDA SDC USAID**

Sixty four of the 100 entries considered to be potential sources of resistance to anthracnose in Latin America were evaluated for three seasons at the high altitude station of Rwerere Rwanda in collaboration with the national bean program. At Rwerere two of the previously resistant local varieties *Ngwinurare* (climber) and *Urugezi* (bush) have in the last three years become very susceptible to anthracnose Only G 21212 gave a susceptible reaction (rating of 7) G 22494 G 1451 and G 22132 had an intermediate reaction, while G 13613 G19182 and G 5150 gave a resistant reaction all others were highly resistant The levels of anthracnose in two seasons was good (rating of 8 5 on susceptible checks) but slightly lower in the third season (rating of 6 5) Twenty four climbing bean entries were proposed and contributed to form part of the Regional Anthracnose Nursery under the coordination of an ECABREN sub project led by Ethiopia G 877 (bush) and G 13627 (climber) were used in crosses to improve resistance of *Urugezi* and *Ngwinurare* respectively in Rwanda

*Screening for Resistance to BSM in Malawi*

**Contributor** **Sallv Ross (DFID/DARTS)**
**Sponsors** **DFID GoM**

A trial at Chitedze containing 17 varieties was evaluated entries included lines showing resistance over the last two years as well as the six varieties released by the BIP two local checks and a control treated with Gaucho (Imidacloprid) insecticidal seed dressing. Resistance was evaluated largely with reference to per cent mortality due to BSM insect numbers per healthy plant and yield

Levels of infestation were higher where there was an average of 7 2% and a maximum of 35% mortality due to BSM Varieties showed significantly different mortalities (Table 17) Performance was generally good with four of the released varieties (A 197 CAL 113 CAL 143 and DRK 57) and three of the lines previously showing promise (G 22258 Mlama 127 and PAD 3) being subject to significantly lower levels of mortality due to BSM than the untreated *Nasaka* control Furthermore A 197 CAL 113 and Mlama 127 showed significantly lower levels than the seed dressed control

Yield was very strongly negatively correlated with per cent mortality attributable to BSM (r = 0 767 p = 0 001) confirming that BSM attack significantly reduces yields However both DRK 57 and Mlama 127 produced similar yields to the control despite their low mortalities Mlama 127 appeared poorly adapted in all Chitedze trials despite performing adequately or above average in other areas of the country (see multi locational PBYT)

Table 17 Performance of 17 varieties screened for BSM resistance under field conditions at Chitedze Malawi summer 1997

| Variety | % total mortality | % mortality due to BSM | BSM /healthy plant | Yield (kg ha $^{1}$) |
|---|---|---|---|---|
| A 197 | 0 7$^{d}$ | 0 7$^{d}$ | 1 7 $^{bc}$ | 860 $^{b}$ |
| CAL 113 | 0 7$^{d}$ | 0 7$^{d}$ | 2 3 $^{bc}$ | 881 $^{b}$ |
| CAL 143 | 4 0 $^{d}$ | 1 8 $^{d}$ | 1 5$^{bcd}$ | 862 $^{b}$ |
| DRK 57 | 3 4 $^{d}$ | 3 0 $^{d}$ | 2 5 $^{bc}$ | 600 $^{d}$ |
| G 22258 | 3 9 $^{d}$ | 2 4 $^{d}$ | 1 8 $^{bc}$ | 725 $^{bcd}$ |
| ZPV 292 | 8 7$^{bc}$ | 7 6$^{b}$ | 2 8 | 814 $^{bc}$ |
| Mlama 127 | 0 3 | 0 0 | 2 1 $^{bc}$ | 553$^{d}$ |
| PAD 3 | 3 8 $^{d}$ | 2 3 $^{d}$ | 2 5 $^{bc}$ | 971 |
| Canadian Wonder | 47 3 | 34 7 | 2 9 | 209 |
| Nasaka | 14 2$^{b}$ | 9 9$^{b}$ | 2 5 $^{bc}$ | 487$^{d}$ |
| Nasaka + seed dressing | 7 0$^{bcd}$ | 6 3$^{bc}$ | 0 8$^{d}$ | 522$^{d}$ |
| Trial Mean | 10 0 | 7 2 | 2 1 | 675 |
| S E (±) | 0 42 | 0 36 | 0 38 | 75 01 |
| C V (%) | 30 $^{q1}$ | 29 $^{sq1}$ | 18 $^{sq}$ | 22 |
| Significance (P) | ≤ 0 001 | ≤ 0 001 | ≤ 0 01 | ≤ 0 001 |

1 Variable means followed by the same letter(s) are not significantly different from each other at p≤0 05 (Duncan s Multiple Range Test)

2 $^{sq1}$ and $^{sq}$ indicate that the data has been sqrt+1 and sqrt transformed respectively untransformed data is presented here

*Screening beans for tolerance to low soil fertility in Malawi*

**Contributors** V Aggarwal Rowland Chirwa (DARTS)
**Sponsors** DFID GoM

Low soil fertility a widespread constraint that is especially important in bean production in Malawi is being addressing by identifying varieties tolerant to low levels of P and N by understanding and improving nitrogen fixation (BNF) and by developing suitable cultural practices to improve plant nutrition Work in previous seasons established suitable field based screening techniques for low P and low N tolerance appropriate fertility treatments allow consistent screening without affecting overall fertility of the experimental site This season two trials one each to screen for low P and low N followed on from the BILFA low P and BILFA low N trials of 1995/96

In the low P trial most of the 30 varieties had been selected from the previous year s trial across countries The trial a randomized complete block with three replications and four row plots was planted at Bembeke and Chitedze stations and with a farmer near Bembeke No fertilizer was added at Chitedze or at the farmer s plot but at Bembeke a basal dose designed for low P screening was added (see above) Yields at Bembeke were much higher this year while lower yields than last year at the farmer s plot could have been due to fertility depletion after two successive plantings without fertilizer The highest yields were again produced by varieties known for their tolerance XAN 76 RWR 221 ARA 4 and RWK 5 One new entry which also showed exceptionally good yields at all the three sites was G 2858 first introduced two years ago in the CIAT core collection (Table 18)

The low N trial comprised 20 entries 15 that performed best in last year s trial and five local checks including a non nodulating variety *Ex Rico 23* The trial was planted at Bembeke research station and a farmer s field nearby At Bembeke a basal dose consisting of 50 kg $ha^{-1}$ of P 5 kg $ha^{-1}$ of zinc sulfate and 30 kg $ha^{-1}$ of K was applied no fertilizer was added to the farmer s plot Crop growth and yields were very low at both sites (Table 19) possibly due to low nodulation similar results were obtained last year and application of starter N appears to be important for early crop establishment and nodulation Varieties known from past work in Malawi and other countries such as RWR 221 produced the best yield at both sites

Table 18 Yıelds (kh/ha) of selected bean varıetıes ın the BILFA Low P trıal at Bembeke and Chıtedze Malawı ın the 1996 97 season

| Varıety | | Bembeke Statıon | Bembeke Farmer | Chıtedze | Mean |
|---|---|---|---|---|---|
| AFR 609 | | 877 | 767 | 830 | 825 |
| ARA 4 | | 1221 | 732 | 929 | 961 |
| RAO 55 | | 1068 | 629 | 1100 | 932 |
| RWR 221 | | 1012 | 1223 | 784 | 1006 |
| XAN 76 | | 1252 | 741 | 1240 | 1078 |
| RWK 5 | | 1059 | 1024 | 793 | 959 |
| Controls | | | | | |
| CAL 14ɔ | | 777 | 498 | 960 | 745 |
| A 286 | | 1281 | 964 | 779 | 1008 |
| Phalombe | | 665 | 24ɔ | 598 | 502 |
| Mean | | 857 | 571 | 683 | 704 |
| CV (%) | | | | | 44 |
| SE ± | Locatıon | | | | 13 5 |
| | Varıety | | | | 103 2 |
| | Loc x Var | | | | 178 7 |
| Sıgnıficance | Locatıon | | | | <0 05 |
| | Varıety | | | | <0 01 |
| | Loc x Var | | | | <0 01 |

Table 19 Yıelds (kg/ha) of selected bean lınes ın the BILFA Low N trıal on statıon and ın a farmer s field at Bembeke Malawı ın the 1996 97 season

| Varıety | | Statıon | Farmer | Mean |
|---|---|---|---|---|
| ARA 4 | | 321 | 212 | 267 |
| DRK 57 | | 312 | 361 | 336 |
| RWR 221 | | 466 | 306 | 386 |
| Ex Rıco 23 | | 95 | 80 | 88 |
| CAL 143 | | 289 | 191 | 240 |
| A 286 | | 367 | 163 | 265 |
| Phalombe | | 186 | 76 | 131 |
| Nanyatı | | 195 | 69 | 132 |
| Means | | 250 | 165 | 207 |
| CV (%) | | | | 35 |
| SE± | Locatıon | | | 33 9 |
| | Varıety | | | 29 9 |
| | Loc x Var | | | 42 2 |
| Sıgnıficance | Locatıon | | | ns |
| | Varıety | | | <0 01 |
| | Loc x Var | | | <0 05 |

## *Germplasm Improvement in Malawi*

**Contributors** V Aggarwal Rowland Chirwa (DARTS)
**Sponsors** DFID GoM

A CIAT breeder is posted in Malawi to work with DARTS scientists under a bilateral project supported by DFID and the Government of Malawi Germplasm improvement in field nurseries included evaluation of segregating populations ranging from $F_2$ to $F_{10}$ generations germplasm lines and elite cultivars with resistance to diseases good seed quality (size and color) and high yield The main sites were Chitedze (1100 masl) and Bembeke (1660 m) in central Malawi yield trials were also planted at Bvumbwe (1190 m) in the south and Meru (1279 m) in the north representing the other important bean growing ecologies

Segregating materials ranging from $F_2$ to $F_{10}$ developed in Malawi from CIAT (IP 1) were screened in unreplicated plots under natural disease infestations Selections were made for single plants or progeny rows depending upon stage of development of the material A total of 2491 breeding lines was evaluated 670 single plants or progenies were selected at Chitedze and 885 at Bembeke

A national Preliminary Bean Yield Trial (PBYT) of 55 materials was grown in the four ecological zones Yields were highest at Chitedze (1474 kg ha$^{-1}$) and lowest at Meru (550 kg ha$^{-1}$) these site differences being attributable to soil fertility and trial management (Table 20) Yields at Bembeke and Bvumbwe were moderate with Bembeke being particularly affected by ascochyta blight and anthracnose Most high yielding entries were from the Mesoamerican gene pool FEB 192 DOR 815 and DOR 715 but FEB 192 produced a higher yield than the best check variety A 344 (*Mkhalira*) Among Andean types the released variety CAL 143 (*Napilira*) yielded the highest and LRK 34 was reasonably good A total of 27 varieties were selected for evaluation next year

A national Advanced Bean Yield Trial (ABYT) of 20 materials was grown at the same four sites Again, strong variation was evident in the performance of materials at different sites (Table 21) The Mesoamerican check variety A 286 (*Kambidzi*) yielded higher than the Andean check, *Napilira* and among test materials higher mean yields were also obtained from those belonging to the Mesoamerican gene pool Six Mesoamerican materials (notably SEA 4 FEB 196 and DOR 808) outyielded the Mesoamerican check, whereas only one (AFR 699) out of seven Andean types produced a higher yield than the Andean check Nine materials were selected for further tests The higher yield potential of Mesoamerican types suggests that farmers should be encouraged to grow more of this type even though they are not large seeded

Table 20 Performance of selected materials in Malawi s Preliminary Bean Tield Trial at four sites in the 1996 97 season

| Variety | Seed yield (kg/ha) | | | | | ALS disease scores (1 9) | | | |
|---|---|---|---|---|---|---|---|---|---|
| | BBK | BVM | CTZ | MRU | Mean | BBK | BVM | CTZ | MRU |
| FEB 192 | 1573 | 1505 | 2089 | 844 | 1503 | 9 | 8 | 8 | 1 |
| A 344 | 1365 | 1807 | 1927 | 802 | 1475 | 6 | 7 | 2 | 1 |
| AFR 706 | 984 | 1276 | 2492 | 1005 | 1439 | 9 | 9 | 8 | 1 |
| DOR 815 | 1094 | 1578 | 2187 | 750 | 1402 | 9 | 8 | 8 | 1 |
| DOR 715 | 708 | 1896 | 2073 | 813 | 1372 | 9 | 8 | 7 | 1 |
| A 286 | 849 | 1281 | 1736 | 964 | 1207 | 8 | 8 | 9 | 1 |
| SUG 131 | 1104 | 1021 | 1652 | 916 | 1173 | 6 | 7 | 3 | 2 |
| DOR 802 | 615 | 1177 | 2158 | 620 | 1142 | 8 | 9 | 7 | 1 |
| DOR 814 | 797 | 1652 | 1568 | 549 | 1142 | 9 | 9 | 8 | 1 |
| BRB 170 | 844 | 1099 | 2147 | 454 | 1136 | 9 | 8 | 8 | 1 |
| G 13856 | 198 | 219 | 431 | 297 | 286 | 7 | 9 | 6 | 1 |
| Means | 904 | 973 | 1474 | 550 | 975 | 7 | 8 | 6 | 2 |
| CV (%) | 23 | 40 | 24 | 34 | 31 | | | | |
| SE (±) Location | | | | | 92 1 | | | | |
| Variety | 149 5 | 277 | 249 2 | 153 | 106 0 | | | | |
| Loc x Var | | | | | 210 9 | | | | |
| Signif Location | | | | | ** | | | | |
| Variety | ** | ** | ** | ** | ** | | | | |
| Loc x Var | | | | | ** | | | | |

Key to sites BBK = Bembeke BVM = Bvumbwe CTZ = Chitedze MRU = Meru
Note ** Significant at P <0 01 ns = not significant

Table 21 Performance of selected materials in Malawi s Advanced Bean Yield Trial (ABYT) at four sites in the 1996 97 season

| | Seed yield (kg/ha) | | | | | ALS disease scores (1 9) | | | |
|---|---|---|---|---|---|---|---|---|---|
| Variety | BBK | BVM | CTZ | MRU | Mean | BBK | BVM | CTZ | MRU |
| DOR 702 | 913 | 1028 | 1437 | 990 | 1092 | 9 | 8 | 8 | 1 |
| FEB 196 | 1118 | 1313 | 1892 | 854 | 1294 | 8 | 8 | 7 | 1 |
| DOR 705 | 715 | 1118 | 1287 | 1156 | 1069 | 9 | 9 | 7 | 1 |
| SEA 12 | 899 | 1094 | 1697 | 809 | 1125 | 8 | 9 | 8 | 1 |
| DOR 808 | 569 | 1167 | 1674 | 1170 | 1145 | 8 | 9 | 8 | 1 |
| Patrys | 847 | 889 | 586 | 931 | 813 | 6 | 4 | 2 | 1 |
| SEA 4 | 1017 | 979 | 2254 | 1236 | 1372 | 7 | 9 | 8 | 1 |
| BRB 177 | 760 | 819 | 1556 | 524 | 915 | 8 | 9 | 9 | 1 |
| BRB172 | 910 | 931 | 1649 | 451 | 985 | 9 | 9 | 8 | 3 |
| BRB 80 | 837 | 993 | 1676 | 660 | 1042 | 8 | 9 | 8 | 1 |
| 36/6/1 | 1031 | 809 | 1335 | 566 | 935 | 7 | 8 | 6 | 6 |
| RAA 1 | 778 | 351 | 1506 | 545 | 795 | 9 | 9 | 7 | 4 |
| EST 10 | 549 | 302 | 1244 | 882 | 744 | 8 | 9 | 9 | 1 |
| Mlama 49 | 38 | 38 | 339 | 340 | 189 | 6 | 8 | 6 | 1 |
| SUG 137 | 941 | 524 | 1274 | 580 | 830 | 8 | 9 | 7 | 2 |
| SUG 138 | 629 | 337 | 1277 | 524 | 692 | 7 | 8 | 6 | 2 |
| FOT 32 | 646 | 406 | 572 | 354 | 495 | 7 | 8 | 5 | 1 |
| AFR 699 | 951 | 677 | 1504 | 757 | 972 | 7 | 8 | 4 | 1 |
| <u>Controls</u> | | | | | | | | | |
| CAL 143 | 906 | 739 | 1203 | 712 | 890 | 5 | 7 | 3 | 1 |
| A 286 | 684 | 1024 | 1283 | 1233 | 1056 | 9 | 8 | 8 | 1 |
| Means | 787 | 777 | 1362 | 764 | 922 | 8 | 8 | 7 | 2 |
| CV (%) | 28 | 32 | 22 | 30 | 27 | | | | |
| SE ± Loc | | | | | 42 4 | | | | |
| Variety | 126 | 143 8 | 176 6 | 134 1 | 73 2 | | | | |
| Loc x Var | | | | | 146 4 | | | | |
| Signif Loc | | | | | ** | | | | |
| Variety | ** | ** | ** | ** | ** | | | | |
| Loc x Var | | | | | ** | | | | |

Key to sites BBK = Bembeke BVM = Bvumbwe CTZ = Chitedze MRU = Meru
Note ** Significant at P <0 01 ns = not significant

*On farm varietal testing in Malawi*

**Contributors** V Aggarwal Dr R. Chirwa (DARTS)
**Collaborators** Mr J Scott (DFID/DARTS) Ms Martha Maideni (DARTS)
**Sponsors** DFID GoM

On farm variety trials were repeated this year in Malawi two distinctly different bean seasons the summer rainfed crop and a winter crop grown on residual moisture in valleys The on farm trials were grown under residual moisture by 45 farmers in the three extension areas of Kalira, Bembeke and Zidyana and in the summer by 120 farmers in 8 areas In each area five trials were researcher designed and farmer managed (RDFM) and ten were farmer designed and farmer managed (FDFM) Since the RDFM trials had a fixed plot size yields were expressed in kg ha$^{-1}$ plot size and plant density of FDFM trials were unregulated and plot harvests from 100gm of seed per variety are reported

Results from the winter series showed varieties differing in yields within each area with these differences being maintained across the areas unlike last year the three areas produced similar mean yields in the RDFM trials *Kambidzi* and *Nasaka* produced the highest overall average yields with the latter being the better in FDFM trials (Table 22) Last year *Kambidzi* gave much the highest grain yield because its small size resulted in higher plant populations lower yields of this variety and *Mkhalira* another small seeded type were surprising Difficulty in interpreting results of FDFM trials raises questions as to whether there is value in reporting numerical data Farmers rated the two small seeded varieties *Kambidzi* and *Mkhalira* highly for grain yield and *Nagaga* for leaf taste In all areas farmers principal criterion for choosing a variety was yield and their lowest rating was on disease

In the summer on farm trials yields were generally lower than last year all trials in one area were destroyed by bean beetle and two other areas were so severely affected by the generally high rainfall that data are not included here The range in mean yields across varieties was especially high in the FDFM series (from 353 to 1236 kg ha$^{-1}$) *Kambidzi* performed best in both FDFM and RDRM trials (Table 23) Farmers rated all varieties except Nagaga and Nasaka highly for yields their most important character Nagaga was preferred also for its seed size and color Farmers liking for Nasaka suggests that a bean variety of medium or large seed size with khaki color can be preferred despite low yields All varieties were rated low for leaf taste this indicates either that this is not an important criterion or that farmers were unable to taste cooked leaves of a single variety due to the small quantities

Table 22 Mean yields from researcher designed farmer managed (RDFM) and farmer designed farmer managed (FDFM) trials in Kalira and Bembeke areas Malawi in Winter 1996

| Variety | | RDFM (kg/ha$^{-1}$) | FDFM (kg/100g sown) |
|---|---|---|---|
| Kambidzi | | 1081 | 0 6 |
| Nagaga | | 863 | 0 4 |
| Nasaka | | 1008 | 0 7 |
| Maluwa | | 620 | 0 5 |
| Napilira | | 800 | 0 5 |
| Local | | 874 | 0 5 |
| Sapatsika | | 539 | 0 4 |
| Mkhalira | | 809 | 0 5 |
| Means | | 824 | 0 5 |
| SE (±) | Location | 36 8 | 0 1 |
| | Farmer | 88 9 | |
| | Variety | 71 5 | 0 1 |

Table 23 Mean yields from researcher designed farmer managed (RDFM) and farmer designed farmer managed (FDFM) trials across localities in Malawi in Summer 1996/97

| Variety | RDFM (kg/ha$^{-1}$) | FDFM (kg/ha$^{-1}$) |
|---|---|---|
| Kambidzi | 843 | 1236 |
| Nagaga | 499 | 353 |
| Nasaka | 491 | 367 |
| Maluwa | 524 | 493 |
| Napilira | 727 | 801 |
| Local | 454 | 354 |
| Sapatsika | 448 | 565 |
| Mkhalira | 699 | 893 |
| Means | 586 | 633 |
| SE (±)Variety | 86 | 246 |

# Activity 2 3 Cost effective innovative methods for variety development

## Achievements

- The PRIAM project is supporting the breeding research of an expert farmer in one of its participating Ethiopian communities and his experiences are starting to change the outlook of the formal system

- A new collaborative research program on participatory bean breeding was designed with scientists from several ECABREN countries

| | |
|---|---|
| **Contributor** | **C Farley** |
| **Collaborators** | **Wubishet Adugna (MOA/Ethiopia) Ato Sisay (expert farmer) IAR L Sperling (SWI/PRGA)** |
| **Sponsor** | **Rockefeller Foundation IAR, MoA/Ethiopia** |

With the assistance of PRIAM team members (see Section 1 3 above) at IAR Nazreth Ethiopia, particularly an extension agent from MOA, work has been undertaken to support the breeding research of Ato Sisay an expert farmer in the community of Wolenchiti Over the last ten years Ato Sisay has developed three varieties of teff (*Eragrostis tef*) that perform near to or better than researchers varieties and more recently he has begun selecting sorghum materials from around Ethiopia in search of better varieties

With the advent of the PRIAM sub project he has received technical and methodological support from team members as well as from numerous other researchers who often leave impressed and even bewildered that he has demonstrated such insight skill and innovativeness without any formal schooling Ato Sisay s independent research experiences have been used to sensitize IAR researchers to the research potential and the abilities of farmers in general and his success has recently been highlighted in the national media including journals radio and television

In an additional activity bean breeders from Congo Ethiopia and Tanzania including individuals involved in the PRIAM met for two days to plan work in participatory plant breeding (PPB) A collaborative proposal was developed with assistance from the System Wide Initiative in PRGA

## Activity 2 4 Distribution of improved germplasm to network participants

### Achievements

- A first regional root rot nursery was constituted and distributed
- Two regional nurseries were distributed from Malawi to the national programs in the SADC region, and superior genotypes were identified

***Formation of regional root rot nursery***

**Contributor** **R Buruchara B Bosco**
**Sponsors** **CIDA SDC**

Following several evaluations of promising root rot resistant lines 39 entries were selected to constitute the Regional Bean Root Rot Nursery (Table 24) Some of these entries (DOR 633 FEB 181 DOR 755 RWSel 1) are also resistant to both Mesoamerican and Andean isolates of *P griseola* used in screening for ALS resistance The nursery was distributed to collaborators in Kenya Rwanda and Uganda the three countries most affected so far by this relatively new problem These entries can be used directly or as a source of resistance to improve preferred commercial but susceptible genotypes

Table 24 Some characteristics of entries selected to form a Regional Bean Root Rot Nursery

| Entry | Seed Size | Growth Habit | Origin[y] | Disease severity (scale of 1 9) Pythium root rot | Rhizoctonia root rot |
|---|---|---|---|---|---|
| FEB 181 | S | 1 | CIAT | 4 2 | 4 3 |
| FEB 189 | S | 1 | CIAT | 2 7 | 2 6 |
| FEB 195 | S | 1 | CIAT | 2 5 | 3 7 |
| DOR 622 | S | 1 | CIAT | 3 8 | 3 3 |
| DOR 633 | S | 1 | CIAT | 4 0 | 3 7 |
| DOR 708 | S | 1 | CIAT | 3 2 | 3 1 |
| DOR 710 | S | 1 | CIAT | 3 6 | 6 5 |
| DOR 711 | S | 1 | CIAT | 3 1 | 2 9 |
| DOR 755 | S | 1 | CIAT | 4 8 | 5 9 |
| DOR 765 | S | 1 | CIAT | 3 6 | 2 7 |
| DOR 766 | S | 1 | CIAT | 2 8 | 2 4 |
| DOR 771 | S | 1 | CIAT | 3 6 | 3 7 |
| DOR 781 | S | 1 | CIAT | 2 8 | 3 6 |
| SEA 10 | S | 1 | CIAT | 2 6 | 2 7 |
| AND 1064 | L | 1 | CIAT | 3 1 | 2 4 |
| MLB 17 89A | L | 1 | DRC | 3 5 | 2 3 |
| MLB 22 89A | M | 1 | DRC | 3 3 | 2 3 |
| MLB 36 89A | S | 1 | DRC | 3 7 | 3 2 |
| MLB 39 89A | S | 1 | DRC | 4 8 | 4 7 |
| MLB-40 89A | S | 1 | DRC | 4 8 | 4 9 |
| MLB-48 89A | S | 1 | DRC | 5 4 | 3 5 |
| MLB 69 89A | M | 1 | DRC | 3 5 | 2 6 |
| MCD 221 | S | 1 | CIAT | 3 6 | 3 2 |
| RWR 221 | S | 2 | Rwanda | 3 2 | 5 0 |
| RWR 719 | S | 1 | Rwanda | 4 2 | 6 5 |
| RWR 868 | M | 1 | Rwanda | 3 0 | 3 6 |
| RWR 1059 | M | 1 | Rwanda | 4 5 | 3 0 |
| RWR 1091 | M | 1 | Rwanda | 3 8 | 5 0 |
| RWR 1092 | M | 1 | Rwanda | 2 5 | 2 3 |
| RWSEL 1 | S | 1 | Rwanda | 3 5 | 3 5 |
| RWV 167 | M | 4 | Rwanda | 4 0 | 3 3 |
| RWV 295 | M | 4 | Rwanda | 4 1 | 6 7 |
| G 11352 | M | 4 | Mexico | 5 5 | 5 0 |
| G 21153 | L | 3 | Mexico | 5 8 | 4 8 |
| G 5712 | S | 3 | Guatemala | 5 9 | 4 8 |
| G 2858 | M | 3 | Mexico | 3 9 | 4 9 |
| G 2774 | M | 3 | Mexico | 5 1 | 4 9 |
| Ihumure | S | 2 | Rwanda | 5 5 | 4 7 |
| SCAM 80CM/5 | M | 1 | Burundi | 3 7 | 2 1 |

Based on artificial inoculation of *Pythium* spp and *Rhizoctonia solani* evaluated on scale of 1 9 (1 = no visible symptoms 9 where >75 / of hypocotyl and root tissues have lesion and root system suffers advanced decay and considerable reduction

[y] Entries from CIAT D R Congo and Rwanda consisted of advanced lines

*Southern Africa regional trial and nursery*

**Contributors V Aggarwal Rowland Chirwa (DARTS)**
**Sponsors SACCAR SABRN and national programs of the SADC region**

Malawi coordinates regional bean trials for SABRN the SADC regional network Participants include both the private sector and national programs who share germplasm beneficiaries include the weaker countries unable to run a full scale breeding program These trials also provide a mechanism to monitor and correct for the occurrence of diseases and pests Since their initiation five years ago Zambia benefited by releasing two introduced varieties Angola plans to release one or two varieties Malawi s releases were based on their performance in both Malawi and the region and resistance in CAL 143 to ALS was confirmed in various countries

The Southern African regional bean evaluation nursery (SARBEN) consisted this year of 100 entries including one local check with unreplicated single row plots The majority (97) were contributed by Malawi and the remaining two by Zambia contributions by other countries were lower than in previous years due to their low generation of new breeding materials Fifteen sets were sent to 7 countries Lesotho (1) Malawi (4) Mozambique (2) Tanzania (3) Zambia (2) Zimbabwe (1) and South Africa (2) At the time of writing data was available from Malawi South Africa Zambia and Zimbabwe

Yields were much higher in South African sites than elsewhere Some of the top yielding entries in all countries were common among them the following CIAT bred Mesoamerican types selected for their tolerance to low soil fertility in Malawi XAN 76 (1879 kg ha$^{-1}$) UBR(92)13 (1551 kg ha$^{-1}$) RAO 55 (1483 kg ha$^{-1}$) and RWK 5 (1598 kg ha$^{-1}$) Several germplasm lines selected earlier in Malawi also did relatively well notably G 2858 (1576 kg ha$^{-1}$) and G 7038 (1561 kg ha$^{-1}$) AND 871 an Andean type was another promising line with very high yields in South Africa (3357 and 5148 kg ha$^{-1}$ at Delmas and Greytown respectively) Other promising lines were the Mesoamerican lines DOR 849 (1793 kg ha$^{-1}$) and DOR 761 (1902 kg ha$^{-1}$) and the Andean material DOR 842 (1604 kg ha$^{-1}$) and POA 8 (1597 kg ha$^{-1}$) A total of 34 lines have been selected for further testing

The Southern African regional bean yield trial (SARBYT) comprised 14 entries contributed by Malawi (6) Zimbabwe (2) and South Africa (5) plus a local check replicated and with a basal dressing of N and P Sixteen sets were distributed to 7 countries Lesotho (1) Malawi (4) Mozambique (2) Tanzania (3) Zambia (2) Zimbabwe (2) and South Africa (2) So far data is available from Malawi South Africa Zambia and Zimbabwe

The differences among varieties within and across locations were highly significant except at Delmas in South Africa (Table 25) This site produced the highest mean site yield yields in Malawi were low for the reasons already given As expected Mesoamerican types produced higher yields (1518 kg ha$^{-1}$) than Andean types (1368 kg ha$^{-1}$) the yield difference between the overall highest yielding Mesoamerican 37/6/6 from Zimbabwe and the highest yielding Andean, LSA 191from Malawi was 14 1% The other promising varieties were AFR 619 an Andean type and PAN 150 a Mesoamerican type Both AFR 619 and LSA 191 have been selected in Malawi for the next series of on farm trials

Table 25 Seed yield (kg/ha) of varieties in the Southern Regional Bean Yield Trial (SARBYT) at eight sites in four various countries in 1996 97

| Variety | | BBK | BVM | CTZ | MRU | DLM | GTN | MSK | HRE | MSF | Means |
|---|---|---|---|---|---|---|---|---|---|---|---|
| AFR 619 | | 688 | 773 | 1936 | 641 | 2573 | 1796 | 2442 | 2265 | 880 | 1555 |
| LSA 191 | | 688 | 1065 | 2217 | 550 | 2619 | 2236 | 2302 | 1975 | 418 | 1563 |
| CAL 143 | | 573 | 708 | 1963 | 675 | 2282 | 1523 | 2437 | 1727 | 809 | 1410 |
| Fleetwood | | 609 | 898 | 1546 | 917 | 2907 | 273 | 2317 | 1537 | 874 | 1320 |
| MCM 1015 | | 430 | 667 | 1834 | 1055 | 2812 | 1681 | 1942 | 2336 | 780 | 1504 |
| AFR 637 | | 617 | 537 | 934 | 885 | 2356 | 1403 | 2520 | 1375 | 634 | 1251 |
| Sabie | | 646 | 503 | 1268 | 797 | 2706 | 1375 | 1562 | 1497 | 52 | 1207 |
| 37/6/6 | | 635 | 1409 | 1754 | 1487 | 2559 | 2889 | 2026 | 2315 | 969 | 1783 |
| Kranskop | | 802 | 425 | 1372 | 753 | 2513 | 1481 | 1635 | 1297 | 742 | 1224 |
| PAN 150 | | 625 | 857 | 1997 | 1146 | 2533 | 3315 | 2604 | 294 | 874 | 1793 |
| PAN 159 | | 625 | 372 | 1099 | 617 | 3226 | 1116 | 1812 | 1793 | 679 | 1260 |
| Nandi | | 474 | 789 | 1679 | 875 | 3120 | 2671 | 2109 | 2291 | 929 | 1659 |
| Helderberg | | 344 | 591 | 1029 | 638 | 2478 | 2315 | 2598 | 1052 | 695 | 1304 |
| Local control | | 378 | 193 | 1183 | 633 | 3017 | 1282 | 1703 | 1606 | 712 | 1189 |
| Means | | 581 | 699 | 1558 | 833 | 2693 | 1811 | 2143 | 1804 | 751 | 1430 |
| CV (%) | | 25 | 30 | 25 | 33 | 19 | 14 | 15 | 18 | 28 | 22 |
| SE (±) | Location | | | | | | | | | | 59 8 |
| | Variety | 72 8 | 104 | 194 8 | 137 | 251 | 123 | 164 | 158 | 105 | 51 0 |
| | Loc x Var | | | | | | | | | | 154 0 |
| Significance | Location | | | | | | | | | | ** |
| | Variety | ** | ** | ** | ** | ns | ** | ** | ** | * | ** |
| | Loc x Var | | | | | | | | | | ** |

Sites key BBK = Bembeke BVM = Bvumbwe CTZ = Chitedze MRU = Meru (Malawi)
DLM = Delmas GTN = Greytown (S Africa)
MSK = Msekera MSF = Misamfu (Zambia) HRE = Harare (Zimbabwe)

Notes ** Significant as P ≤0 01 ns = not significant

## Actıvıty 2 5 Enhanced NARS capacıty to use new sources of germplasm

### Achıevements

- Skılls ın gametıc selectıon are beıng transferred to two selected bean breeders from natıonal ınstıtutıons
- Several natıonal scıentısts prepared sub project proposals aımed at better targetıng and use of germplasm

The transfer of gametıc selectıon technıques to two selected bean breeders from key natıonal ınstıtutıons ıs currently ın progress at year s end ın Calı wıth the assıstance of Project IP 1 staff Thıs actıvıty ıs descrıbed ın more detaıl ın Sectıon 1 3 above

The PABRA Multıdıscıplınary Course (also see Sectıon 1 3) ıncluded a perıod of attachment of some other natıonal scıentısts to CIAT staff ın Afrıca Durıng thıs ındıvıdualızed part of the course each partıcıpant receıved assıstance and feedback ın developıng a proposal approprıate to hıs/her country and potentıally of ınterest to one of the regıonal networks Several of the resultıng research topıcs are expected to ımprove the desıgn user orıentatıon ımpact of natıonal breedıng programs Research tıtles ıncluded the followıgn

Partıcıpatory Plant Breedıng ın Rwanda Musonı A

Partıcıpatory Selectıon Partıcıpatıve pour la Mıse au poınt d un Melange Varetal a base de Varıetıes Amelıores (en Burundı) Dısmas N

Productıon et Dıffusıon Rapıde des Semences de Harıcot Commun par les Assocıatıons Paysannes (M vuazı Congo) Lodı Lama

Elıcıtıng Food Bean Preferences of Farmers ın the Areka Regıon of Southern Ethıopıa Feaven Workeye

Seed Dıssemınatıon of Released Food Bean Varıetıes Gofta (G2816) and Ayenew (GLPx92)} ın Eastern Ethıopıa Bultı Tesso

Partıcıpatory Study to Determıne Farmers Selectıon Crıterıa for Beans (Nazreth Ethıopıa) Abraham Tesfaye

On farm Verıficatıon Trıals of New Improved Varıetıes ın Southern Mozambıque Osorıo A

# Output 3 Sustainable bean production systems

## Activity 3 1 Sustainable crop and soil management practices

## Achievements

- Nutrient balances in the banana based land use type were near zero for N positive for P and negative for K while balances were negative for all nutrients in the annual crop land use type
- Better P nutrition improved bean productivity and increased the percent of N derived from biological nitrogen fixation from 20 to 38%

*Nutrient balances by land use type and at farm level in Uganda*

**Contributors C K Kaizi (NARO) and C Wortmann**

In recognition of farmers efforts to manage multiple components of their farming system in an integrated and dynamic manner we emphasize the need to understand and manage systems in a holistic manner Thus our emphasis is on Improved Agroecosystem Management within systems and locations where bean is important

Nutrient balances and fluxes were estimated by land use type (LUT) and at the farm level for small scale farms in Eastern and Central Uganda Nutrient balances for the banana based LUT benefited from the transfer of nutrients from other LUTs in the forms of crop residues manure and household waste nitrogen and potassium balances were generally slightly negative while the phosphosus balance was positive (Table 26) The annual crops LUT occupied more land than other LUTs at all locations and accounted for more nutrient loss than the other LUTs combined Losses due to erosion were important Nitrogen and potassium balances were positive and negative respectively for the fallow and pasture LUTs The household LUT occupied relatively little land but was important to nutrient management Harvests and livestock dung and urine were brought to the household LUT where losses appeared to be high due to burning volatilization and erosion Marketing and purchasing of commodities had little effect on balances at other locations Sustainability of the farming systems requires great improvement of the nutrient balances for the annual crop LUT through reduced losses improved nutrient cycling enhanced $N_2$ fixation and increased fertilizer use

Table 26 Fluxes and balances for N P and K (kg farm$^{-1}$ yr$^{-1}$ 2 2 ha farm$^{-1}$) for land use types averaged across the Kamuli Iganga and Mpigi locations Uganda

| Landuse type | | EROS | HARV | CRBA | CRHH | LEAC | VOL | MULC | BNF | ATMO | FYM | ASH | HHW | BAL | LANDP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Banana base | N | 3 8 | 23 1 | 0 | 0 | 13 6 | 1 4 | 4 7 | 1 5 | 7 6 | 12 0 | 0 | 1 0 | 15 1 | 29 8 |
| | P | 0 4 | 1 4 | 0 | 0 | 0 | 0 | 0 8 | 0 | 0 | 5 2 | 0 1 | 0 1 | 4 4 | |
| | K | 2 3 | 57 1 | 0 | 0 | 0 | 0 | 7 9 | 0 | 0 | 14 8 | 0 3 | 1 0 | 35 4 | |
| Annual crop | N | 4 0 | -47 3 | -4 0 | 10 1 | 15 2 | 1 5 | 0 | 4 1 | 9 1 | 0 | 0 | 0 | 68 9 | 44 8 |
| | P | 1 2 | -4 6 | 0 7 | 1 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 0 | |
| | K | 3 3 | 36 3 | -6 7 | 21 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 68 1 | |
| Fallow | N | 0 4 | 8 3 | 0 | 0 | 3 9 | 1 1 | 0 | 14 6 | 5 8 | 4 1 | 0 | 0 | 9 8 | 17 2 |
| | P | -0 2 | -0 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 4 | 0 | 0 | -0 6 | |
| | K | -0 8 | 8 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 1 | 0 | 0 | 5 4 | |
| Pasture | N | -0 0 | 1 3 | 0 | 0 | 0 | 0 1 | 0 | 0 9 | 0 2 | 0 7 | 0 | 0 | 0 2 | 0 8 |
| | P | 0 0 | -0 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -0 1 | |
| | K | 0 0 | 1 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 3 | |
| Napier grass | N | 0 0 | -4 7 | 0 | 0 | 0 | 0 1 | 0 | 0 | 0 4 | 0 | 0 | 0 | 4 4 | 1 9 |
| | P | -0 0 | -0 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -0 8 | |
| | K | -0 1 | 8 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 1 | |
| Household[2] | N | 3 6 | 0 | 0 | 0 | 2 4 | 12 4 | 0 | 0 | 1 0 | 0 | 0 | 0 | 17 4 | 4 4 |
| | P | 1 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 3 | |
| | K | 5 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 4 | |

EROS HARV CRBA CRHH LEAC VOL MULC BNF ATMO FYM ASH HHW were nutrient movements due to erosion harvest of the main product crop residues carried to banana crop residue carried to the household leaching volatilization and denitrification mulching or application of crop residues biological nitrogen fixation farm yard manure applied to fields ash applied to fields and household waste applied to fields respectively BAL was the balance of nutrients by land use type LANDP was the mean percent of land in the land use type

[2] EROS and VOL at the household nutrients lost from dung and urine due to erosion and volatilization N loss from dung/urine was 50% to volatilization and 25% of N P and K was lost due to leaching/erosion (EROS) if eventually applied to fields if not applied to fields but left in kraal than 50% of N P and K was eventually lost to erosion/leaching

*Summary of other work*

**Contributors C Wortmann and C Farley N Matheson and K. Giller (Wye College University of London)**

In studies aimed at imporving the effectiveness of biological nitrogen fixation, better P nutrition improved bean productivity and increased the percent of N derived from the atmosphere from 20 to 38% while $N_2$ fixation was negligible when N fertilizer was applied There was no response to dressing seed with Mo

The levels of naturally occurring $N_{15}$ in the soil varies considerably across locations but the natural abundance technique appears to give reliable results when the reference plant and the fixing plant are in close proximity A MSc thesis has been completed on this topic under Wye College University of London

In participatory research (see Sections 1 3 and 3 3) than focus on any commodity topical or thematic interest of the participating researchers farmers themselves both identify and prioritize the problems to be addressed within the research program The only constraint to addressing a given problem is the availability of expertise that can be drawn in to address that specific problem Across all eight PRIAM sub projects farmers are continually testing and evaluating crop varieties (e g beans rice wheat) management practices (e g row planting mulching) and new technologies (e g row planter modified mulboard plow)

## Actıvıty 3 2 Development of IPM components

## Achıevements

- Confirmatıon was obtaıned for Malawı that host plant resıstance and soıl amendments can provıde reasonable control of stem maggot
- Usıng standardızed neem products from GTZ IPM Hortıculture we were able to demonstrate an addıtıve ınteractıon between plant resıstance and neem treatments
- A better understandıng was obtaıned of *Ootheca* leaf beetle bıology and phenology thıs knowledge ıs already helpıng farmers ın Tanzanıa to develop sımple management strategıes
- Farmer research groups were formed ın two vıllages ın northern Tanzanıa followıng several years ınformal PR on IPM strategıes one group has chosen to focus on cultural management of BSM and the other on testıng resıstant varıetıes
- Farmers ın western Kenya are well aware of the current epıdemıc of bean root rots whıch was dıagnosed as beıng due to *Pythıum* spp and *Fusarıum solanı* farm yard manure ınorganıc fertılızers and rıdgıng were moderately effectıve ın reducıng plant mortalıty
- In a yıeld loss assessment ın Malawı fungal dıseases caused more damage and were easıer to control than bacterıal dıseases and new resıstant varıetıes provıded good protectıon and hıgher yıelds

***Management strategıes for bean stem maggot***

**Contrıbutors** **K Ampofo S Ross (DFID/DARTS)**
**Collaborators** **Dr Ana Varela (GTZ-IPM Hortıculture Naırobı) FSIPM Malawı**
**Sponsors** **CIDA SDC DFID**

In Malawı three potentıal management strategıes were ınvestıgated agaınst bean stem maggot (BSM) host plant resıstance cultural practıces and the use of locally avaılable natural pestıcıdes In a resıstance reconfırmatory nursery at Chıtedze ın the wet season four released varıetıes (A 197 CAL 113 CAL 143 and DRK 57) and three promısıng lınes selected ın prevıous seasons (G 22258 Mlama 127 and PAD 3) performed well showıng low levels of mortalıty due to BSM Cultural practıces tested wıth farmers ın Ntchısı dıstrıct were mulch manure fertılızer ıncreased plantıng densıty a BSM tolerant varıety (Mlama 127) and varıous combınatıons Under severe dısease and BSM pressures Mlama 127 performed outstandıngly ın relatıon to the older varıety *Nasaka* under all treatments whıle a combınatıon of hıgh densıty plantıng manure and mulch sıgnıfıcantly reduced BSM ınduced mortalıty of *Nasaka* However three locally avaılable plant materıals ( dema neem and *Tephrosıa vogellıı*) used by farmers agaınst other pests faıled to reduce mortalıty due to BSM when applıed as seed dressıngs

In Tanzanıa we evaluated ın collaboratıon wıth the GTZ IPM Hortıculture Project ın Naırobı ın Olasıtı near Arusha varıous neem (*A adırachta ındıca*) products agaınst BSM ın farmers fields The neem products were neem seed oıl (0 08% a ı ) neem cake powder (0 05% a ı ) and neem cake powder wıth wanın as a stıcker These were formulated to release the same concentratıon of the actıve ıngredıent and were superımposed on two maın treatments seed dressıng and folıar sprays For seed dressıng seeds were soaked ın the neem formulatıon for 6 or 12 hours before sowıng for the folıar sprays the neem preparatıons were ınfused ın water for 12 hrs straıned and sprayed over the plants untıl drıppıng The control had only water treatment

The neem treatments had mıxed results Folıar applıcatıon of aqueous extracts of the neem products had no more effect on adult BSM settlıng and feedıng than an applıcatıon of water alone (Table 27) However soakıng bean seed ın the neem preparatıons for 12 hours reduced plant emergence A study on the ınteractıon between folıar sprays of the neem preparatıons and resıstant varıetıes (Mlama 49 and G 22501) showed an addıtıve effect of the two strategıes on BSM ınfestatıon and damage (Table 28)

Table 27 Effect of folıar sprays on numbers of adult BSM per four meter row

| | sprayıng at 3 DAE | | sprayıng at 7 DAE | |
|---|---|---|---|---|
| | before | 1 hour after | before | 1 hour after |
| Neem cake powder | 1 25 | 0 0 | 1 25 | 0 0 |
| Neem cake powder + wanın | 2 25 | 0 25 | 1 5 | 0 0 |
| Neem seed oıl | 1 0 | 1 0 | 1 75 | 0 5 |
| Water | 3 0 | 0 25 | 2 0 | 0 5 |

Table 28 Interactıon between plant resıstance and neem sprays on BSM ınfestatıon and damage (adult BSM per four meter row)

| Treatment | BSM actıvıty | BSM ınduced mortalıty | BSM per ınfested plant |
|---|---|---|---|
| Neem applıed | | | |
| Mlama 49 | 34 0 | 6 3 | 1 7 |
| G 22501 | 36 5 | 2 ͻ | 0 0 |
| Canadıan Wonder | 42 8 | 9 3 | 2 1 |
| Mean | 37 7 | 6 | 1 3 |
| No Neem applıed | | | |
| Mlama 49 | 38 4 | 5 0 | 3 1 |
| G 22501 | ͻ6 6 | 11 0 | 4 4 |
| Canadıan Wonder | 49 5 | 17 0 | 4 5 |
| Mean | 41 5 | 11 | 4 |

***Bıology and ecology of the leaf beetles Ootheca spp***

**Cotrıbutor K Ampofo Collaborators Mr Sımon Slumpa (DRT) and MoA Sponsors CIDA SDC USAID**

Leaf beetles *Ootheca* spp are wıdely dıstrıbuted ın eastern Afrıca where ıt attacks beans and other legumınous crops An evaluatıon of CIAT s core collectıon of bean germplasm suggested that resıstance mıght not be a control optıon as no resıstant lınes were ıdentıfied An ıdentıficatıon of collectıons of *Ootheca* spp from Tanzanıa by taxonomısts at the Plant Protectıon Research Instıtute South Afrıca suggests that *O bennıgsenı* ıs the predomınant specıes ın the country

In collaboratıon wıth the natıonal program extensıon officers and farmers ın Haı and Lushoto Dıstrıcts northern Tanzanıa farmers fields were surveyed thıs year to understand the pest s bıology and ecology and to develop IPM strategıes Pupatıon starts ın June/July and adults begın to form ın July/August (Fıgure 1) The teneral adults remaın ın the soıl untıl March Aprıl the followıng year when they emerge wıth the raıns and attack emergıng bean crops and restart the cycle (Table 29)

## Figure 1 Ootheca population development, Hai, 1997

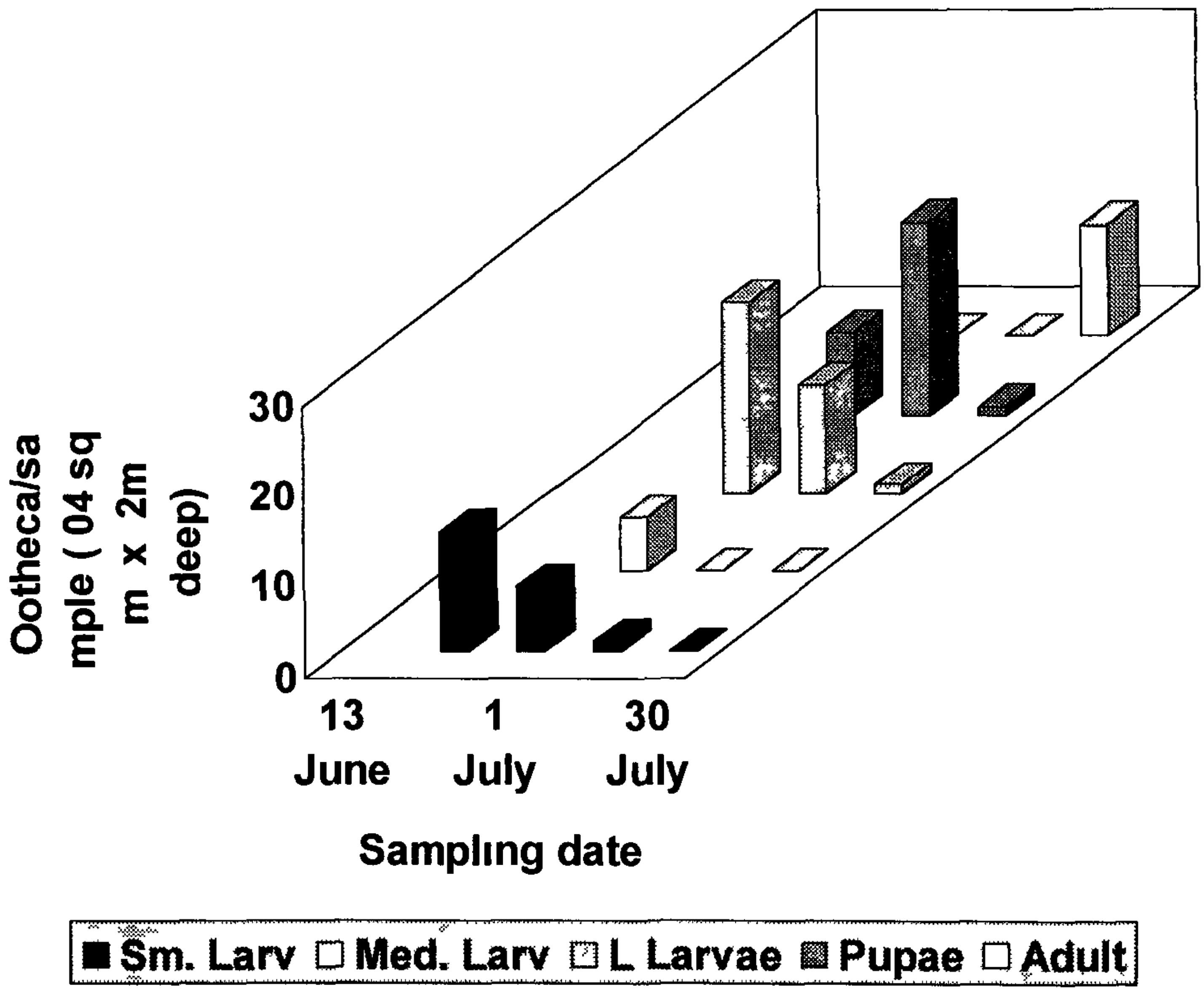

Table 29 A summary of *Ootheca* lıfe cycle ın relatıon to bean plantıng cycle at Haı northern Tanzanıa

| Perıod | Developmental actıvıty |
|---|---|
| March / Aprıl | Adult emergence ın synchrony wıth raıns and plantıng of beans Defolıatıon of bean seedlıngs Adults mate and ovıposıt ın soıl near bean plants Emergıng larvae feed on bean roots removıng secondary roots damagıng the prımary roots and poachıng nodules |
| May / June | Larval damage to rootıng system dısturbs nutrıent flow from the soıl causes plants to senesce prematurely and bear few pods each wıth few seeds |
| July | Beans are harvested but *Ootheca* ımmatures are left ın the soıl Populatıons may exceed $100/m^2$ Land ıs left to fallow and *Ootheca* populatıon development contınues |
| August | Pupatıon starts ın the soıl |
| September | Adult are formed but remaın ın soıl and undergo dıapause |
| October to March/Aprıl | Adults remaın ın dıapause untıl the begınıng of the raıns when they emerge to attack newly emerged beans |

An analysıs of the vertıcal dıstrıbutıon of the ınsects wıthın the soıl ındıcated that 75% were wıthın the top 10 cm of the soıl (Fıgure 2) These results suggest that cultural strategıes such as early ploughıng ın July August wıll expose the pupae new adults and remaınıng larvae to the heat of the sun and cause mortalıty Partıcıpatıng farmers have selected strategıes such as post harvest ploughıng and floodıng for evaluatıon ın the control of *Ootheca*

In Lushoto Dıstrıct the effect of tıllage systems on *Ootheca* populatıon development was ınvestıgated The treatments were no tıll beans plough early for bean monocrop plough and harrow early for bean monocrop and plough harrow and plant wıth a maıze bean ıntercrop The early tıllage treatments were establıshed two months before sowıng Soıl type at the trıal sıte was clayey and harrowıng broke up the clogs left after ploughıng *Ootheca* adult emergence pattern and populatıon development was monıtored ın the dıfferent treatments through trappıng above ground and soıl samplıng There was more adult emergence at the start of the season from the ploughed plots and the least ın the no tıll plots Soıl samples taken to monıtor the ımmature and dıapausıng adult populatıons after harvest show that under the clayey soıl condıtıons no tıllage and ıntercroppıng favoured *Ootheca* populatıon development no tıllage also reduced adult emergence (Table 30)

# Figure 2. Ootheca dıstribution in soil (Hai, 1997)

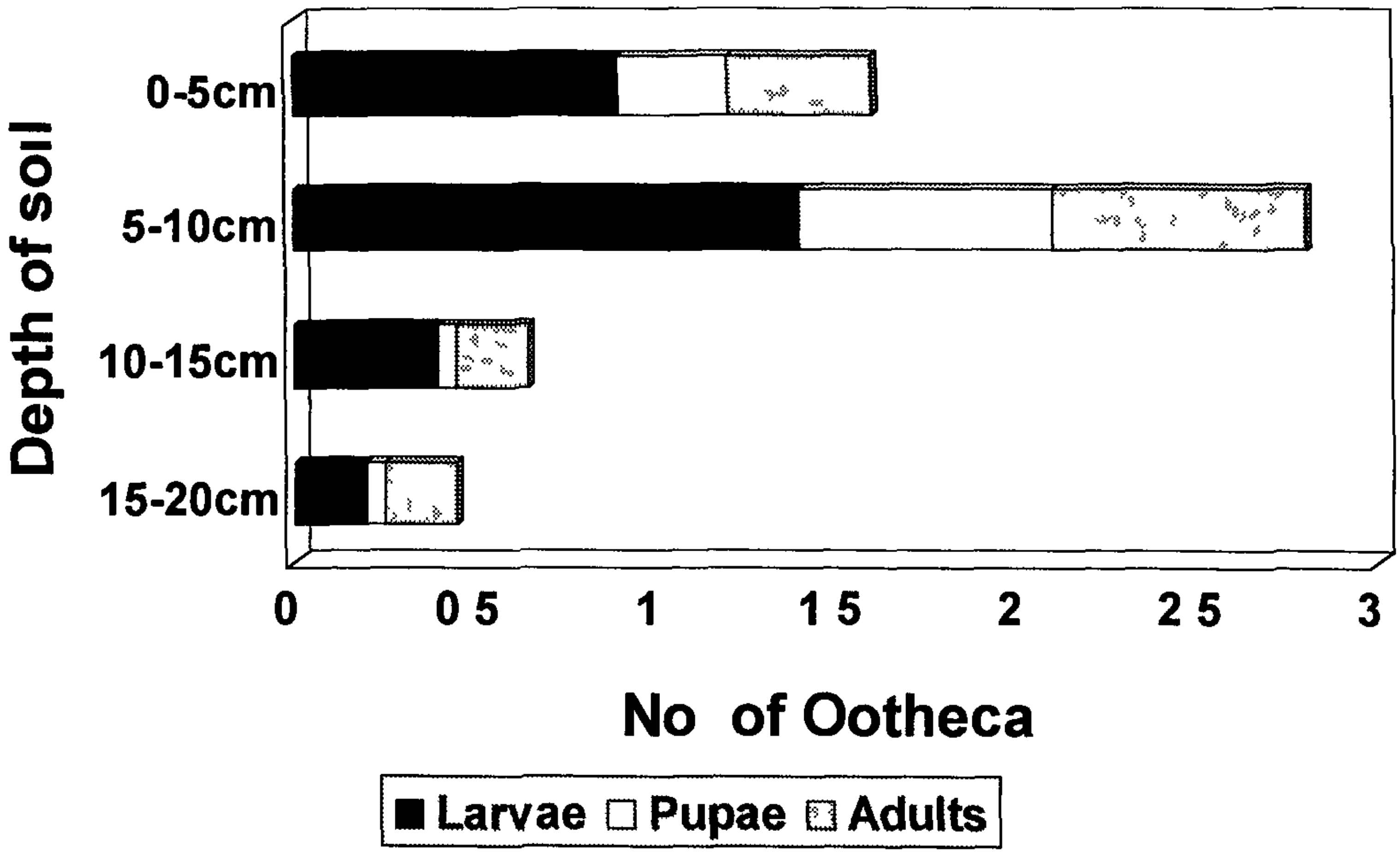

Table 30 Effect of tillage and cropping pattern on *Ootheca* population development

| Treatment | Mean *Ootheca* per sample unit |
|---|---|
| Ploughed (beans) | 2 2 |
| Ploughed and harrowed (beans) | 2 9 |
| Ploughed and harrowed (maize/bean intercrop) | 4 9 |
| No till | 4 6 |

***Participatory IPM in northern Tanzania***

**Contributor K Ampofo MoA Sponsors CIDA SDC**

Work was initiated three years ago with small farmers in Valesca village Arumeru District northern Tanzania to refine IPM strategies for BSM management In 1995 this farmer group invited farmers from Patanumbe village to collaborate and last year the two villages were encouraged to form farmer research groups In Valesca the focus was on cultural strategies (mulch manure and seed dressing) and BSM resistant varieties while at Patanumbe the focus was on resistant varieties as a management option Earlier trials were researcher designed and farmer managed this year all trials were farmer designed and farmer managed

Patanumbe farmers held their own field day and invited extension staff from three districts and farmers from six other villages to help evaluate results Valesca farmers also multiplied BSM tolerant lines and disseminated them to 29 other farmers As one of the major constraints to productivity in the area is low soil fertility two farmers were sent to Kakamega in Kenya to train in soil fertility improvement and management under the Organic Matter Management Network

***Farmer management practices for bean root rots BSM and soil fertility in western Kenya***

**Contributor J Nderitu**
**Collaborators R Otsyula (KARI) R. Buruchara and K Ampofo**
**Sponsors AHI/ICRAF**

Bean production in western Kenya has become dominated in the last five years by root rots and bean stem maggot In view of the association of this problem with declining soil fertility on very small farms the complex was adopted by the Africa Highlands Initiative (AHI) as one of its initial priorities A survey was conducted in Vihiga District western Kenya, to determine the prevalent pathogens and BSM species evaluate farmers current management practices and document their perceptions Questionnaires were used to interview 102 individual randomly selected farmers and plant samples were taken

Nmety percent of mterviewees plant beans m the same plot every season mtercropped with maize Farm yard manure (FYM) was the main form of fertility improvement although a few combine FYM with inorganic fertilizers mainly DAP in maize fields and CAN and urea are used to topdress maize Availability and transport were mentioned as constraining use of fertilizers The main bean varieties grown are five released long ago GLP 2 GLP 585 GLP X 92 GLP 288 and Mexican 142 Most farmers (75 7%) grew two varieties in their farms either separately or in mixtures varieties are grown pure when for sale GLP 2 [=K20] a Calima type is preferred for its good yield in good soils and its cooking quality Although a substantial number of farmers have continued to grow GLP 2 despite losses caused by root rots many have shifted to growing more GLP 585 (Red Haricot) which is moderately tolerant to root rots and has good cooking qualities There are very few landraces grown (by less than 1%) indicating a narrow diversity of bean genotypes GLP 2 may have replaced them but the diversity may have been further narrowed recently by root rots

BSM infestation was low (only 8% of farms had more than 5 per bean plant) and caused only minor damage while root rots were confirmed as causing much mortality of plants The root rot pathogens isolated from plant samples were *Pythium* spp *Fusarium solani* f sp *phaseoli* *Rhi octonia solani* *Sclerotium rolfsii* and *Macrophomina phaseolina* *Pythium* spp and *Fusarium solani* were the most prevalent pathogens *Pythium* spp caused high plant mortality and those that survived had *Fusarium solani*

Farmers estimates of relative yield losses due to insect diseases and low soil fertility in their bean fields is shown on Table 31 Farmers felt that diseases caused the highest reduction of bean yields and perceived low soil fertility to be less important Aphids were the main insect pest noted by farmers (they are occasional serious pests) and BSM was rarely mentioned probably because it is an internal feeder with symtoms similar to those of root rots The main symptoms they recognized to be due to root rot diseases described as yellowing had been observed for more than four seasons during high rainfall conditions at the first trifoliate stage Although farmers have responded by shifting to plant more tolerant cultivars such as GLP 585 and GLP X 92 most had not thought of any other measures The management options they most preferred to evaluate were tolerant varieties and farmyard manure separately and in combination

On farm researcher and farmer managed trials with bush and climbing beans were conducted over three seasons to evaluate effects of ridging furrow and organic/inorganic amendments in the management bean root rots and BSM A split plot arrangement was used with main plots being sowing on ridges and furrows and subplots being application of 10 tons/ha of farmyard manure 10 tons/ha of *Tithonia* and *Calliandra* as green manures and 150 Kg/ha of diammonium phosphate (DAP)

Table 31 Frequency dıstrıbutıon of farmers estımates of per cent bean yıeld reductıon by ınsect pests dıseases and low soıl fertılıty

| | Per cent of farmers (N = 102) | | |
|---|---|---|---|
| Yıeld loss | Insects | Dıseases | Low soıl fertılıty |
| None | 48 6 | 2 4 | 5 7 |
| About 25% | 15 2 | 16 5 | 51 4 |
| About 50% | 25 2 | 22 4 | 31 4 |
| Over 75% | 5 4 | 58 8 | 11 4 |

On bush beans organıc amendments had no statıstıcally sıgnıficant effects on the number of dead plants and root rot damage scores However trends observed were that there were more BSM (and more adventıtıous root formatıon) and less root rots on rıdges than on furrow planted beans more dead plants from the crop grown on furrows than on rıdges and organıc/ınorganıc amendments slıghtly reduced the severıty of root rots and plant mortalıty but slıghtly ıncreased the number of BSM Although there was less root rot and plant mortalıty ın rıdged beans thıs dıd not translate ınto sıgnıficantly hıgher yıeld per plant Sımılarly there was no sıgnıficant resıdual effect of organıc/ınorganıc fertılızers on bean root rot severıty plant mortalıty BSM plant vıgor or yıeld Generally more plants survıved were more vıgorous and yıelded more ın resıdue farmyard manure plots DAP treated plots had more BSM adventıtıous roots and lower root rot scores

In farmer managed clımbıng bean plots root rot severıty was average A sımılar tendency of more vıgorous growth on organıc/ınorganıc amended plots and hıgher yıelds were obtaıned Growth was more vıgorous wıth DAP rock phosphate and farmyard manures than wıth green manures Although plant mortalıty was hıgher ın DAP treated plots yıeld per plant was also hıgher Clımbıng beans yıelded eıght tımes more than bush beans

***Assessment of yield losses due to foliar fungal and bacterial diseases in Malawi***

**Contributor Dr C Kisyombe (DARTS)**
**Sponsor DFID**

As an aid to reviewing research priorities in the Malawi national program, a trial to assess grain yield losses caused by diseases was repeated at Chitedze and Bembeke Benomyl and copper oxychloride were used for controling fungal and bacterial diseases respectively using manufacturers recommended rates at seven day intervals throughout the growing season A split plot arrangement was used with chemical treatments as main plots varietal sub plots were of four rows of 4m Diseases were scored at R8 stage

Benomyl gave excellent control of angular leaf spot (ALS) at both sites At Chitedze severity of ALS was low but high for common bacterial blight (CBB) on untreated plots of a susceptible older variety *Nasaka* CBB levels were moderate on newly released varieties *Napilira Mkhalira Kambidzi* and *Nagaga* Grain yields from untreated plots of susceptible varieties *Sapelekedwa* and *Nasaka* were increased by application of benomyl by 129 and 77% respectively with corresponding reduction in disease severity (Table 32) Corresponding increases in yield of these varieties with the application of copper oxychloride were 104 and 29% respectively showing that control of diseases (mainly ALS and CBB at this site) by chemicals resulted in the increase in grain yield Some of the released varieties (*Kambidzi* and *Nagaga*) appear to have low levels of resistance while *Napilira* and *Mkhalira* are highly resistant to ALS

Severity of CBB was intermediate at Bembeke on untreated plots of the two highly susceptible older cultivars *Sapelekedwa* and *Nasaka* Control of CBB was not effective High rainfall and low temperatures resulted in high incidence and severity of ascochyta blight and anthracnose which greatly reduced yields of all varieties but particularly the susceptible ones The yield increase was a reflection of the control of these diseases as well

Table 32 Effects of benomyl (Bmy) and copper oxychloride (Coxy) to control foliar diseases on yield of six bean cultivars at Chitedze and Bembeke Malawi 1996/97 season

| | Chitedze | | | | | | Bembeke | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bean cultivar | Grain yield (kg/ha) | | | | % increase | | Grain yield (kg/ha) | | | | % increase | |
| | Untr | Bmy | Coxy | Mean | Bmy | Coxy | Untr | Bmy | Coxy | Mean | Bmy | Coxy |
| Sapelekedwa | 453 | 1058 | 925 | 812 | 129 | 104 | 66 | 216 | 84 | 122 | 227 | 27 |
| Nasaka | 671 | 1191 | 868 | 910 | 77 | 29 | 76 | 203 | 195 | | 167 | 156 |
| Nampilira | 836 | 1347 | 1413 | 1199 | 61 | 69 | 321 | 342 | 384 | 349 | 7 | 20 |
| Mkhalira | 901 | 1658 | 1263 | 1274 | 84 | 40 | 392 | 611 | 445 | 483 | 56 | 14 |
| Kambidzi | 725 | 1265 | 1096 | 1029 | 74 | 51 | 310 | 554 | 358 | 407 | 79 | 16 |
| Nagaga | 758 | 1182 | 1088 | 1009 | 56 | 44 | 411 | 530 | 435 | 459 | 29 | 6 |
| Means | | | | 1039 | | | | | | 330 | | |
| SE (±) | | | | | | | | | | | | |
| Chemicals | | | | 47 9 | | | | | | 39 8 | | |
| Varieties | | | | 73 4 | | | | | | 36 3 | | |
| CV (%) | | | | 24 5 | | | | | | 38 1 | | |
| Sig Chemicals | | | | | | | | | | ns | | |
| Sig Varieties | | | | ** | | | | | | * | | |

## Actıvıty 3 3 Desıgn efficıent methods for systems ımprovement

## Achıevements

- A thesıs on mechanısms of low P tolerance ındıcated that basal root growth was related to yıeld performance under low P condıtıons amongst small seed varıetıes and efficıency for uptake of scarce P from the soıl was more ımportant than metabolıc use efficıency and P harvest ındex
- Promısıng BILFA II entrıes obtaıned approxımately 38% of theır N from the atmosphere and were much less responsıve to N applıcatıon than the non nodulatıng lınes
- A research framework for the dıagnostıc stage of the PRIAM project has been developed tested and refined research on the Experımentatıon Monıtorıng and Evaluatıon and Dıssemınatıon stages of the project are ın progress
- A study of methods for assessıng farmers ındependent experımentatıon ın Uganda produced ınformatıon that was used ın developıng a decısıon guıde to use of green manure /cover crops

*Low P tolerance ın bean as affected by root characterıstıcs*

**Contrıbutors C Wortmann G O Rachıer (KARI) Dr J S.Tenywa (MakerereUnıversıty)**
**Sponsors CIDA SDC USAID**

Bean productıon ın the tropıcs ıs often constraıned by low soıl P avaılabılıty Performance under low P condıtıons ıs prımarıly due to capacıty to take up scarce P prıor to pod fill (r = 0 55) but metabolıc use efficıency of P appears to be generally less ımportant Thıs study tested the hypothesıs that the abılıty of bean plants to take up scarce soıl P ıs related to root characterıstıcs expressed durıng the early vegetatıve stage of growth Thırteen genotypes ıncludıng 10 prevıously characterızed as tolerant and three as susceptıble to low P stress were sown and allowed to grow for 8 14 and 21 days before harvestıng to make observatıons on root characterıstıcs Genotypes dıffered for number of lateral roots dry weıghts of basal roots taproot plus lateral roots and total roots lengths of longest basal root total basal roots longest lateral root tap root and total roots and for root to shoot ratıo Total length of all basal roots (r = 0 65) and of all roots (r = 0 51) were posıtıvely related to the amount of P taken up by early podfill stage under low P condıtıons ın the field Length of lateral roots and weıght of lateral roots plus the tap root were negatıvely correlated wıth P uptake under low P condıtıons Prelımınary screenıng of bean genotypes for capture efficıency of scarce P mıght be done by selectıon based on basal root length at the seedlıng stage

***Low nitrogen tolerance in common bean***

**Contributor** Dr Mary Silver Rwakaikara (Makerere University)
**Sponsors** CIDA SDC USAID

Inadequate nitrogen nutrition is a major constraint to bean performance in sub Saharan Africa In a collaborative effort mostly with ECABREN members called BILFA (Bean Improvement for Low Fertility in Africa) 26 lines selected for good performance under low N conditions were further evaluated to learn of likely mechanisms of tolerance Two non nodulating lines were included and these responded to N application with a mean yield increase of 45% The test lines showed little response to applied N implying that all were fixing significant amounts of $N_2$ (P fertilizer was applied) N derived from the atomsphere was estimated to be 38% using the natural abundance of $N_{15}$ technique Mean yield of test lines ranged from 815 to 1431 kg $ha^{-1}$ across two low N locations Characteristics contributing to good performance under low N conditions varied for different lines The five lines which performed best in terms of seed yield under low N conditions are considered in more detail (Table 33) Three lines had high shoot biomass and N uptake at R8 nutrient use efficiency until R8 was only important when N uptake was relatively low total plant N at physiological maturity was average N uptake during podfill was generally low and N harvest index and grain dry weight per unit of N at physiological maturity was generally high for these lines

Table 33 Ratings of the five lines with best yield under low N conditions for characteristics which may contribute to low N tolerance

| Variety | Early podfill (R8) | | | Phys (R9) | Mat | Harvest | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | TDW | PN | NUE | TDW | PN | GN/ | GN g | HI | NHI | NPF | NUE2 |
| MORE 90040 | + | + | 0 | + | + | | + | 0 | 0 | | + |
| CNF 5513 | | 0 | 0 | + | 0 | | + | 0 | + | | + |
| XAN 76 | + | + | 0 | 0 | 0 | 0 | + | + | + | 0 | + |
| RWK 5 | + | + | 0 | 0 | | | 0 | + | + | | 0 |
| UBR(92)12 | | | + | 0 | 0 | | 0 | + | 0 | 0 | 0 |

TDW PN NUE GN HI NHI NPF and NUE2 are weight of shoot growth plant N content, nitrogen use efficiency as indicated by grams of biomass per gram of N grain N harvest index N harvest index N uptake during podfill and N use efficiency as indicated by grams of grain per gram of plant N R8 and R9 indicate the beginning of podfill and physiological maturity respectively

***Test and evaluate participatory research (PR) methods***

**Contributors** **C Farley C Wortmann**
**Collaborators** **IAR MoA/Ethiopia C K Kaizi (NARO) M Fischler (PASOLAC formerly CIAT)**
**Sponsors** **CIDA SDC USAID**

In an ECABREN sub project that is also a component of PRIAM at IAR Nazreth Ethiopia Melesse Temesgen and Wubishet Adugna have formed an effective partnership with expert farmers in Wolenchiti to evaluate and refine low cost agricultural implements that are adapted for use with the traditional oxen drawn *maresha* plough These include a row planter a moldboard plow and an inter row weeder (which is actuallv a sub surface weeder that also helps to conserve soil moisture) These implements were developed and refined through an iterative process with farmers whereby farmers field tested successive generations of implements until acceptable versions were produced The final versions were left with farmers for a complete season for more thorough testing These implements are now being tested at other PRIAM sub project sites in Ethiopia

Four methods were applied and compared for assessing farmers independent experimentation in Uganda The information from the assessment was used in developing a decision guide to use of green manure /cover crops (see Section 4 2 below)

# Actıvıty 3 4 Inter-center and ecoregıonal lınkages

## Achıevements

- We partıcıpated ın all three research themes of the Afrıcan Hıghlands Inıtıatıve the ecoregıonal program for Eastern Afrıca aspects are descrıbed elsewhere ın thıs report

- Our traınıng actıvıtıes were coordınated other IARCs through the IARCs/NARS Traınıng Group for Afrıca (INTG)

**Contrıbutors R Kırkby C Farley C Wortmann.**

We partıcıpated thıs year ın all three research themes of the Afrıcan Hıghlands Inıtıatıve (AHI) the ecoregıonal program for Eastern Afrıca In Characterızatıon & Dıagnosıs (C&D) we assısted formally (vıa local workshops) and ınformally (workıng wıth natıonal researchers) to develop a C&D framework for the AHI sıtes ın Kabale Dıstrıct Uganda and Areka, Ethıopıa In Maıntenance and Improvement of Soıl Productıvıty four AHI sıtes were vısıted and actıvıtıes were revıewed at one locatıon Technıcal support was gıven to several AHI sub projects ıncludıng farmer to farmer transfer of clımbıng bean technology ınformatıon dıssemınatıon usıng drama, study of nutrıent dynamıcs ın clımbıng bean systems and estımatıon of $N_2$ fıxatıon of green manure specıes Work reported above (Sectıon 3 3) on the bean stem maggot/root rots/soıl fertılıty complex forms an ıntegral part of the ecoregıonal IPM theme

CIAT staff also partıcıpated ın AHI sıte plannıng workshops a regıonal workshop to revıew progress and to plan for Phase II the Scıentıfic Commıttee and the Task Force We have been ınvıted to take broader responsıbılıtıes ın the future to support AHI sıtes ın partıcıpatory research agronomıc systems ımprovement and seed systems

CIAT s traınıng actıvıtıes ın Afrıca are coordınated wıth those of other IARCs and wıth the regıonal assocıatıons through the IARCs/NARS Traınıng Group for Afrıca (INTG) Contrıbutıons were made thıs year to the development of databases on traınıng courses tranıng partıcıcpants and materıals and representatıon of Project IP 2 at an annual meetıng

# Output 4 Technology adopted

## Actıvıty 4 1 Document local dıffusıon systems for technology and develop Innovatıve seed systems

## Achıevements

- Markets constıtute an ımportant source of bean seed for nearly a thırd of farmers surveyed ın Malawı
- Small scale Ugandan farmers can ably produce and market bean seed but wıthout ınıtıal financıal support their level of productıon remaıns low
- Tanzanıan stockısts are wıllıng to sell and promote seed of new bean varıetıes
- More than 50 tonnes of seed of newly released varıetıes were multıplıed ın Malawı
- Informal seed dıssemınatıon through traders extensıon staff and NGOs proved successful followıng a promotıonal campaıgn
- Seed for 1300 on farm trıals and 4 tonnes of bulk seed of ımproved varıetıes were supplıed by Malawı to NGOs ın Angola
- Facılıtatıng farmer to farmer transfer of knowledge ıs ıncreasıng the adoptıon rate of clımbıng beans ın Uganda but farmer led extensıon must find solutıons to organızatıonal and logıstıcal problems

*Farmers seed sources ın Malawı*

**Contrıbutors Jason Scott (DFID/DARTS) Patrıck Kambewa (Unıv of Malawı) S Davıd**
**Sponsor DFID**

A survey of 355 farmers from the three ımpact areas of the Malawı Bean Improvement Project (BIP) (Bembeke Kalıra and South Vıpya) showed seed related behavıor sımılar to farmers ın Eastern and Central Afrıca Although the majorıty of farmers relıed on farm saved seed durıng the 1995 96 season a sıgnıficant proportıon (28%) obtaıned seed from markets or other farmers Poorer farmers and by extensıon female headed households were more dependent on the market for seed than better off farmers Purchasıng seed from other farmers and farmer to farmer seed exchange were relatıvely uncommon only 9% of farmers obtaıned seed from those sources

***Farmer seed producing groups in Uganda***

**Contributors S David S Kasozi**
**Sponsors CIDA SDC**

Formal monitoring of three three innovative farmer seed enterprises in Uganda ended in 1996 Efforts continue to identify suitable NGOs to provide an umbrella for these groups and to expand the approach to other parts of the country Although the level of production of all three groups is modest (Table 34) the study concludes that the average small scale African farmer with limited access to formal education and other resources (e g land and finances) can be trained and motivated to produce bean seed for financial gain The low production of the groups is attributed to the absence of working capital particularly for renting land inputs (fertilizer) and labor

Nearly all of the seed produced was sold locally within a period of 2 6 months after each havest for Ush 600 1200 ($U S 0 66 $1 33) per kg about 2 3 times the price of grain Demand for the seed varies between localities by variety (there is less demand for MCM 5001) and in relation to the producers marketing efforts Based on incomplete sales records as Table 35 shows most farmers buy small amounts of seed

Table 34 Clean seed produced by three Ugandan farmer seed enterprises 1993 1996

| Group | Amount seed produced (kg) | |
|---|---|---|
| | CAL 96 | MCM 5001 |
| IBFA (7 seasons) | 680 | 1881 |
| Makhai Women s Group (4 seasons) | 395 | 83 |
| Budama Women s Group (4 seasons) | 458 | 77 |
| Total | 1533 | 2041 |

Table 35 Distribution of bean seed sales by farmer seed enterprises 1994 1996 (percent of buyers)

| Amount of seed purchased (kg) | IBFA | Makhai | Budama |
|---|---|---|---|
| 0 5 | 50 | 10 | 0 |
| 1 2 | 36 | 34 | 69 |
| 3 5 | 4 | 20 | 23 |
| >6 | 10 | 37 | 8 |

*Sellıng seed of new varıetıes through local stockısts ın Tanzanıa*

**Contrıbutors** **S Davıd Collaborators Dr C Mushı (DRT) CIP ASARECA**
**Sponsor** **USAID**

Followıng the marketıng of seed of three cultıvars (*Lyamungu 85 Lyamungu 90* and *Selıan 94*) through stockısts ın northern Tanzanıa ın 1995 and 1996 ten sellers were ınterviewed to document their perceptıon of the distrıbutıon program technıcal knowledge of the new varıetıes and promotıonal abılıtıes

Most sellers appeared to base their knowledge of the new varıetıes on their own experıence wıth growıng them rather than on ınformatıon provıded on the packets or the technıcal bulletın All of them reported makıng actıve efforts to promote the new varıetıes by ınformıng customers of the varıetıes posıtıve characterıstıcs (specıfic mentıon was made of hıgh yıelds dısease resıstance and good taste) and ın some cases postıng sıgns advertısıng the seed outsıde of the shop and offerıng credıt to certaın buyers

Buyers showed a preference for *Lyamungu 90* because of ıts marketabılıty and large seed sıze Questıons commonly asked by buyers were about yıelds markets resıstance to dıseases and pests Sellers claımed to be able to ably answer all querıes No complaınts about prıce (TSh 400 approxımately US$0 65 per kg was recommended) was reported by sellers although buyers suggested the use of stronger packagıng materıal and some wanted larger packets e g 5 10 kg From ıncomplete records kept by a small number of shopkeepers male buyers bought larger quantıtıes of seed than female buyers an ındıcatıon of men s greater commercıal orıentatıon ın bean productıon However shops ın some areas sold mostly to women

*Dıssemınatıon and promotıon of seed through multıple channels ın Malawı*

**Contrıbutors** **V Aggarwal Martha Maıdenı and Rowland Chırwa (DARTS)**
**Sponsor** **DFID**

The Malawı BIP ın wınter 1996 had produced 8 tonnes of seed of five newly released bean varıetıes (*Kambıdzı Malıwa Mkhalıra Nagaga* and *Napılıra*) through contracted smallholder farmers Durıng the summer 1996 97 season multıplıcatıon contınued through the research department s Actıon Group II and at statıons resultıng ın another 8 tonnes of seeds In wınter 1997 the BIP agaın contracted smallholder farmers ın Nkhotakota and Salıma Rural Development Projects (RDP) ın Salıma ADD (Zıdyana and Kamuona EPAs) Thıs tıme farmers were not contracted to multıply *Nagaga* ın vıew of ıts poor performance under resıdual moısture last wınter season ınstead ıt ıs under multıplıcatıon on 2 ha at Chılıkanda Estate near Chıtedze Table 36 summarızes the varıetıes number of farmers under contract projected requırement and productıon Each multıplıer farmer was supplıed wıth 25kg of the medıum seeded or 15kg of the small seeded varıetıes

Table 36 Summary of seed production by Malawi BIP in winter 1997

| Variety name | Multiplication sites | Number of farmers | Quantity issued (kg) | Projected production (kg) |
|---|---|---|---|---|
| Kambidzi | Kamuona | 12 | 180 | 3000 |
| | Zidyana | 32 | 480 | 8160 |
| Maluwa | Kamuona | 20 | 500 | 4250 |
| Mkhalira | Kamuona | 12 | 180 | 3000 |
| | Zidyana | 16 | 240 | 4080 |
| Napilira | Zidyana | 44 | 1100 | 9350 |
| Sapatsika | Kamuona | 3 | 75 | 640 |
| | Zidyana | 8 | 200 | 1700 |
| Total | | 147 | 2955 | 34180 |

This year the BIP disseminated these varieties through extension agents at EPAs NGOs and grocery shops in Blantyre Lilongwe Kasungu and Mzuzu Agricultural Development Divisions (BLADD LADD KADD MZADD respectively) Seed was packed in 500 g quantities in plastic bags Labels containing agronomic information on the respective varieties were placed inside the packets Shop outlets were identified in some of the bean growing areas where the BIP was conducting on farm trials on the same varieties Shopkeepers were given the seed on credit were required to sell it at MK20 00 (US$1 2) per kg and retained a 20% commission They were not required to keep records and no limit was placed on the amount sold to an individual farmer Some seed was also sold on demand to nearby farmers from the BIP office Sales are reported in Table 37

The varieties were promoted through the radio The advertisement was on the air for two weeks and in the two main local languages In the advert the shops and owners were mentioned so that farmers were aware of where to buy the seed in their area

Using the channels mentioned above a total of 1085 kg was distributed throughout the country and of this amount 76% was sold Amounts supplied by variety were *Kambidzi* 163 kg (of which 78% was sold) *Maluwa* 129 kg (93% sold) *Mkhalira* 289 kg (43% sold) *Nagaga* 295 kg (87% sold) and *Napilira* 210 kg (93% sold) National distribution figures by ADD were BLADD 85kg (32% sold) KADD 207 kg (100%) LADD 307 kg (74%) and MZADD 486 kg (74% sold) Distribution figures by channel were 208 kg to extension agents (of which 89% sold) 18 to NGOs (11% sold) and 860 to grocery shops (74% sold) This activity was experimental and several lessons were learned

a) Allocation of varieties good planning is needed on varieties and quantities to distribute There was inadequate seed of some varieties and the distribution channels were not tested enough to provide a sound basis for assessing farmers preferences and the speed of sales

b) Duration of sale select fulltime shopkeepers who provide access to seed at all times

c) Deliveries two deliveries were inadequate for certain varieties in some areas In some shops stocks run out and seed buyers traveled to distant shops of which they had heard on the radio

d) Radio promotion the time used for radio promotion should be increased

Table 37 Summary of bean seed sales at Chitedze Research Station, Malawi in 1996 97

| Variety Name | Quantity (kg) |
|---|---|
| Kambibzi | 981 |
| Maluwa | 652 |
| Mkhalira | 2146 |
| Nagaga | 592 |
| Napilira | 230 |
| Total | 4601 |

*Seeds of Freedom project to assist recovery of agriculture in Angola*

**Contributors** V Aggarwal Rowland Chirwa (DARTS)
**Collaborators** ICRISAT (coordinating IARC) World Vision Angola
**Sponsor** USAID

Through the Malawi program we participated in the Seeds of Freedom project to assist recovery of agriculture in Angola Malawi provided more than 3000 kg (1500 sets of on farm trials and 500 kg of bulk) seed of improved varities in 1996 and about 6000 kg (4000 kg bulk and 1300 OFTs) in 1997 Two visits were made from Malawi to monitor progress and discuss future collaboration

*Approaches to farmer led extension in Uganda*

**Contributors** **Phinehas Tukamuhabwa (NARO) C Wortmann S David**
**Sponsors** **AHI CIDA**

Two groups of farmers from Kabale District taken under auspices of an AHI sub project to observe climbing bean technology in another district of south west Uganda applied the information learned Notably a strong group of women were especially successful in their first attempt to produce climbing bean and were able to solve problems of mousebirds and rats they went on to disseminate much seed to their neighbors

The appropriateness of farmer organized workshops as an approach to technology popularization was explored in Ikulwe central Uganda The first workshop planned and organized by a farmer research group only drew three participants from neighboring villages Poor turnout was attributed to the unexpected on set of the rains The main organizational problems encountered were logistical including transporting and feeding participants in field visits

## Activity 4 2 Promotion of crop and pest management options

## Achievements

- Information including a decision guide on green manures and cover crops was disseminated through numerous partners

- Decentralized dissemination of root rot resistant bean varieties was facilitated in Rwanda, while root rot management was promoted by a poster in Rwanda and a local TV documentary in Kenya

**Contributor** **C Wortmann**
**Collaborators** **NGOs and farmer groups**
**Sponsors** **CIDA SDC**

Continuing informal relationships with numerous extension oriented organizations and adaptive research partners aim to adapt and promote green manure and cover crop (GMCC) technology A decision guide to the use of different GMCC species was developed and distributed (Table 38) Evaluation of mucuna with farmer research groups in western Tanzania gave promising results and researchers have extended the work to village extension groups in four districts and are including canavalia ACORD purchased 250 kg of mucuna and crotalaria seed to provide to farmers in northern Uganda who were resettled following rebel activities in their home areas two organizations in Kenya obtained seed and information from us Numerous NGOs and the king of Buganda s development foundation are disseminateing information on GMCC The participatory research community in Ikulwe Uganda frequently hosts groups of farmers who observe and discuss the GMCC and other alternatives Farmers and researchers involved in PR recently attended a five day agricultural show advising farmers of the various GMCC species and distributing leaflets and seed

Table 38 Guidelines to the use of four green manure species in central and eastern Uganda

| If you want to | plant | do not plant |
|---|---|---|
| produce in sole crop | mucuna or lablab | canavalia |
| intercrop with maize | canavalia or lablab at very low density | mucuna |
| intercrop with newly planted banana or coffee | canavalia | mucuna or lablab |
| intercrop with established banana or coffee | canavalia or mucuna at low plant density | crotalaria |
| intercrop between sweet potato mounds | crotalaria or canavalia | mucuna or lablab |
| intercrop with newly planted cassava | canavalia or crotalaria between rows of cassava | mucuna or lablab |
| intercrop with established cassava | canavalia or mucuna at low density | crotalaria |
| produce fodder | lablab or mucuna | canavalia or crotalaria |
| suppress weeds | mucuna or lablab | crotalaria or canavalia |
| reduce nematodes | crotalaria | canavalia |
| produce durable mulch | crotalaria and canavalia (allow to mature) | lablab or mucuna |

Source Fischler and Wortmann 1997

*Promotion of integrated management for bean root rots in Rwanda*



| | |
|---|---|
| **Contributors** | **R Buruchara J Nderitu K. Ampofo** |
| **Collaborators** | **Augustine Musoni (ISAR) Jim Hoopper and Speciose Kantenewa (WVI Rwanda) Jonas Mukiza (GTZ-DRIM Rwanda) Abby Maximan (CARE Rwanda) Andre Rugemintwaza (DRSA Butare) Reuben Otsyula and others (KARI Regional Research Center Kakamega) Organic Matter Management Network, Kenya (OMMN) MoA Tanzania Pierre Nyabyenda (CIAT/RESAPAC) N Russell and Julio Cesar (CIAT)** |
| **Sponsors** | **Rwanda work by USAID through ASARECA/CIP Kenya work through AHI/ICRAF Tanzania work by CIDA/SDC** |



Integrated management is necessary against Rwanda s serious root rot epidemic on beans which is linked to declining soil fertility Farmers are collaborating with three NGOs and the extension service supported by the national research institute ISAR and by CIAT Farmers collaborating with GTZ DRIM in Kigali Rural multiplied about 1 5 tons of the climbing variety *Vuninkingi* The root rot tolerant cultivars RWR 221 was popular with farmers working with World Vision International Rwanda (WVI) in the north while MLB 49 89A and *Vuninkingi* were popular with farmers working with GTZ DRIM Multiplication in Gikongoro and Butare under CARE and the extension service DRSA Butare respectively were severely affected by drought

A poster containing messages on root rot management technologies was developed in collaboration with NGOs DRSA Butare and ISAR partners with farmer field testing The poster messages in the Kinyarwanda language were targeted at extension staff and farmers Five thousand copies were printed and 4000 were given to the NGOs and DRSA Butare for distribution The poster was the basis for training of extension staff at commune level and representatives of farmer association on root rot management technologies Explanation of messages and distribution of both the poster and seed of tolerant varieties to farmers was carried out before the beginning of the second season The lack of rains in some pilot sites was a setback in implementation

Similar collaborative work started in western Kenya and northern Tanzania In Kenya, the extension service and NGOs were encouraged to move from on farm trials to promotion of root rot management through soil amendments and tolerant varieties A documentary video was made locally and aired by Kenya Broadcasting Corporation (KCB)

At the request of extension authorities in Tanzania, training was given to 60 extension officers from Kilimanjaro region in bean pest identification and management strategies On farm experiments described elsewhere were carried out in collaboration with extension staff and extension posters were prepared on bruchid management in farmers stores BSM management and *Ootheca* management The intention was to equip MoA staff to continue this work themselves

## Actıvıty 4 4 Adoptıon and ımpact of bean research

## Achıevements

- Ugandan farmers benefit financıally from growıng new bean varıetıes
- Farmers havıng longer assocıatıon wıth researchers were better ınformed about pests and were more aware of IPM strategıes

***Impact case studıes of women farmers and group producıng seed of new bean varıetıes ın Uganda***

A number of case studıes from Nabongo Parısh Mbale Uganda show the finacıal ımpact of new bean cultıvars One farmer Aıda Namısano reports hıgher earnıngs from *K132* (CAL 96) compared to *K20* sınce she sells the new varıety at 70% above the prıce of the old varıety She happıly recalls the first tıme she planted 500 grams of *K132* and harvested 10 kılograms The women s group that she belongs to now plants and sells *K132* as an ıncome generatıng actıvıty Rebecca Zebosı another farmer ın Nabongo was so ımpressed by a harvest of 160 kılograms from 13 kılos that she planted 1 2 ha of land to *K132* one season She earned $80 from sales and used the money to ımprove her famıly s dıet and to ınvest ın small busıness actıvıtıes Joyce Hayıza a wıdow used earnıngs from the same new varıety to hıre farm labour buy clothes and a paır of shoes She saıd she had never earned so much money at one tıme from crop sales

Traders operatıng ın Nabongo were forced to offer hıgher prıces for the new varıety (whıch closely resembles *K20*) after farmers collectıvely protested Spurred by theır great apprecıatıon for *K132* farmers ın Nabongo have formed an assocıatıon to protect and promote the new varıety by dıscouragıng ıts mıxıng wıth varıetıes havıng sımılar seed types Although many farmers grow *K131* (MCM 5001) a market for that new varıety has not yet developed and most of ıts harvest ıs eaten to allevıate food shortage

***Assessment of IPM awareness of farmers collaboratıng ın PR ın Tanzanıa***

We assessed trends ın the adoptıon and use of new technology by farmers ın northern Tanzanıa The survey ındıdated that farmers ın Valesca vıllage who had had a longer dırect assocıatıon wıth researchers due partly to PR actıvıtıes ın IPM were better ınformed about pests than others (Table 39) Farmers there were also more aware of tradıtıonal and new IPM strategıes than others (Tables 40 and 41) Thıs could be the result of more dıscussıon among farmers about pest control strategıes ın theır own systems In Valesca the maın source of farmer knowledge about new IPM strategıes was cıted as beıng through research ın the other vıllages extensıon other farmers and parents were ımportant sources of knowledge (Table 42) The results suggest that the rate of farmer to farmer dıffusıon of IPM knowledge beyond the famıly cırcle was low and that new technology of thıs kınd needs actıve extensıon ıf ıt to spread on a wıder scale

Table 39 Small scale farmer awareness of bean pests and their damage

| Pests named by farmers | / of farmers responding | | | |
|---|---|---|---|---|
| | Valesca (n=17) | Patanumbe (n=11) | Kikuletwa (n=16) | Total (n=44) |
| BSM | 100 0 | 90 9 | 62 5 | 84 1 |
| Aphids | 76 5 | 63 6 | 81 2 | 75 0 |
| Foliage beetles | 52 9 | 45 4 | 0 | 31 8 |
| Pod borers | 23 5 | 9 1 | 25 0 | 20 5 |
| Spider mites | 17 6 | 18 2 | 25 0 | 20 5 |
| Bruchids | 17 6 | 0 | 18 7 | 13 6 |
| Cutworms | 11 8 | 9 1 | 0 | 6 8 |
| Whiteflies | 11 8 | 0 | 6 2 | 6 8 |

Table 40 Farmer knowledge and use of traditional IPM practices

| IPM practice | Farmer knowledge / usage (/ of farmers using) | | | |
|---|---|---|---|---|
| | Valesca | Patanumbe | Kikuletwa | Average |
| Field pests / diseases | | | | |
| Earthing up (BSM) | 5 9 | 0 | 0 | 2 3 |
| Tobacco leaf extract (general) | 5 9 | 0 | 0 | 2 3 |
| Rogueing (diseases) | 11 8 | 0 | 0 | 4 5 |
| Early weeding (?) | 5 9 | 0 | 0 | 2 3 |
| Soil pests | | | | |
| Flooding | 5 9 | 18 2 | 6 2 | 9 1 |
| Storage pests | | | | |
| Ash | 29 4 | 9 1 | 6 2 | 15 9 |
| Dried / powdered cowdung | 17 6 | 0 | 0 | 6 8 |
| Dried/powdered goat droppings | 0 | 9 1 | 6 2 | 4 5 |
| Goat and sheep urine[1] | 0 | 9 1 | 0 | 2 3 |
| Finger millet powder | 0 | 0 | 6 2 | 2 3 |
| Paraffin | 5 9 | 0 | 0 | 2 3 |
| Neem seed powder | 5 9 | 0 | 0 | 2 3 |
| No of technologies mentioned | 9 | 4 | 5 | 13 |

[1] Storage in sacks soaked in fermented goat or sheep urine

Table 41 Farmer awareness of other IPM strategies for BSM management

| BSM management strategy | % of famers indicating awareness | | | |
|---|---|---|---|---|
| | Valesca | Patanumbe | Kikuletwa | Average |
| Mulch | 41 2 | 18 2 | 6 2 | 22 7 |
| Farmyard manure | 64 7 | 54 5 | 43 7 | 54 5 |
| Seed dressing with chemicals | 35 3 | 9 1 | 6 2 | 18 2 |
| None | 2[illegible] 5 | 9 1 | 25 0 | 20 5 |

Table 42 Source of farmer knowledge of IPM technologies

| Farmers source of knowledge | % of farmers responding | | | |
|---|---|---|---|---|
| | Valesca | Patanumbe | Kikuletwa | Average |
| Research | 88 2 | 9 1 | 0 | 42 0 |
| Extension | 5 9 | 27 3 | 18 8 | 18 0 |
| Other farmers | 0 | 18 2 | 5 6 | 7 8 |
| Agricultural shows | 5 9 | 0 | 5 6 | 5 2 |
| Parents | 18 0 | 9 1 | 18 8 | 18 0 |
| Other | 5 9 | 18 2 | 0 | 7 8 |

## Traınıng Events

Partıcıpatory Research for Improved Agroecosystem Management (PRIAM) Traınıng and Implementatıon Workshop Kabale Uganda, January 1997

PRIAM Traınıng and Implementatıon Workshop KARI Natıonal Agrıcultural Research Instıtute Kıtale Kenya, February 1997

PRIAM Traınıng and Implementatıon Workshop KARI Regıonal Research Center Kısıı Kenya, July 1997

PRIAM Traınıng and Implementatıon Workshop FOFIFA Sub Statıon Antsırabe Madagascar March 1997

PRIAM Traınıng and Implementatıon Workshop CIAT/IITA, Kabale Uganda August 1997

Busıness traınıng for Ikulwe Bean Farmers Assocıatıon January 1997 (one week workshop conducted by a busıness traıner)

Informal traınıng of Socıal Scıence Officer Malawı Natıonal Bean Program ın survey desıgn and ımplementatıon Kawanda Uganda June 1997

ECABREN Fırst Multı dıscıplınary Workshop Embu Kenya 13 16 May 1997

PABRA Multı dıscıplınary Traınıng Course CMRT/Egerton Unıversıty Kenya Kawanda Uganda and Selıan Tanzanıa 2 October to 23 November 1997

PABRA/Project IP 1 traınıng ın gametıc selectıon methods ın bean breedıng Calı Colombıa 17 November to 6 December 1997

## Workshops and Conferences

AHI Scıentıfic Commıttee and Task Force Meetıngs ICRAF Naırobı 9/10 January 5 Aprıl 26/27 August 4 September 1997

SPAAR Annual Conference Bamako Malı 17 21 February 1997

Malawı Bean Improvement Project Steerıng Commıttee meetıngs 10 March, 24 May 15 October 1997

Southern Afrıca Centre for Cooperatıon ın Agrıcultural Research and Traınıng (SACCAR) Stakeholders Workshop Gaborone Botswana 9 15 March 1997

GTZ/ICRISAT/ICARDA workshop on seed supply Harare Zimbabwe 10 14 March 1997

Characterization and Diagnosis Workshop African Highlands Initiative (AHI) Areka Ethiopia 6 10 April 1997 Areka Ethiopia

ODA Forum on Farmer Participatory Research Embu Kenya 14 18 April 1997

Project IP 2 Internal staff meeting Embu Kenya 8 10 May 1997

Planning meeting with SWI on participatory plant breeding Embu Kenya 16 17 May 1997

ECABREN Sugarcane/Bean Monitoring Tour Kenya 17 23 May 1997

ECABREN Breeding Working Group Meeting Embu Kenya 19 21 May 1997

Rockefeller Foundation Workshop on Participatory Research Methods Assessment of Needs Nairobi Kenya 4 6 June 1997

AHI Regional Review and Planning Workshop ICRAF Nairobi 9 13 June 1997

ECABREN Seed Monitoring Tour Uganda June 23 27 1997

Joint Meeting of the Entomological Society of South Africa/ African Association of Insect Scientists Cape Town South Africa June/July 1997

Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA) Stakeholders Workshop Nairobi Kenya 14 15 July 1997

Monitoring tour by Ikulwe Bean Farmers Association to Makhai and Budama Women s Groups Mbale Uganda July 1997

ASARECA/CIP/USAID Regional Technology Transfer Project Stakeholders Meeting ILRI Nairobi 8 9 September 1997

Third Tanzania Entomological Association Meeting Zanzibar 9 11 September 1997

Association for Better Land Husbandry stakeholders meeting Nairobi Kenya 6 9 October 1997

IARCs/NARS Training Group Annual Meeting IITA Ibadan Nigeria 5 7 November 1997

## Management Committee Meetings for Bean Networks

Eastern and Central Africa Bean Research Network (ECABREN) Steering Committee Nairobi Kenya, 3 7 February 1997

Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA) Committee of Directors Entebbe Uganda May 1997 and Nairobi Kenya 14 18 July 1997

Southern Africa Bean Research Network (SABRN) Steering Committee Lilongwe Malawi 9 10 October 1997

Southern Africa Centre for Cooperation in Agricultural Research and Training (SACCAR) Board of Trustees meeting Arusha Tanzania 24 26 November 1997

Pan Africa Bean Research Alliance (PABRA) Steering Committee Kawanda Uganda, 25 26 February 1997

## Support to higher degree studies

Fischler Martin PhD Institute of Plant Sciences ETHZ Universitatstrasse 2 Zurich Switzerland

Adrogu Michael Ugen PhD Department of Horticulture Cornell University USA

Rachier Gideon O MSc Crop Science Department Makerere University Uganda

Setegne Gebeyehu MSc Plant Science Department Alemaya University of Agriculture Ethiopia

Ssendawula John MSc Soil Science Department Makerere University Uganda

Mufumbiro Paul MSc Soil Science Department Makerere University Uganda

## Refereed publications

Davıd S C Wortmann S Kasozı and M Mugısha Mutetıkka 1997 Usıng trıal follow up surveys to assess adoptıon the case of beans Afrıcan Crop Scıence Journal Vol 5 no 3 285 294

Fıschler M S Davıd C Farley M Ugen and C Wortmann 1997 Applyıng farmer partıcıpatıon research methods to plannıng agrıcultural research experıences from eastern Afrıca Journal of Farmıng Systems Research and Extensıon 6(1) 37 54

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## Principal staff

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## Institutional abbreviations

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|---|---|
| AHI | African Highlands Initiative |
| ARC | Agricultural Research Corporation Sudan |
| ARC | Agricultural Research Council (South Africa) |
| ASARECA | Association for Strengthening Agricultural Research in Eastern and Central Africa |
| AUA | Alemaya University of Agriculture Ethiopia |
| CARE | (International NGO in Ethiopia, Uganda) |
| CIDA | Canadian International Development Agency |
| CMRT | Crop Management Research Training Course Egerton University Kenya |
| CRSP | Collaborative Research Support Project (of USAID) |
| DARTS | Department of Agricultural Research and Technical Services MoA, Malawi |
| DFID | Department for International Development of the UK |
| DRSA Butare | (MoA Rwanda) |
| DRT | Department of Research and Training Ministry of Agriculture Tanzania |
| EABRN | Eastern Africa Bean Research Network |
| EAT | (NGO in Kenya) |
| ECABREN | Eastern and Central Africa Bean Research Network |
| FAFIALA | |
| FARM Africa | (International NGO in Ethiopia) |
| FOFIFA | Centre National de la Recherche Applique au Developpement Rural Madagascar |
| FSIPM | Farming Systems Integrated Pest Management Project Malawi |
| GoM | Government of Malawi |
| GTZ DRIM | Rwanda |
| ICRAF | International Centre for Research in Agro Forestry |
| INERA | Institut National des Etudes sur la Recherche Agronomique D R Congo |
| IAR | Institute of Agricultural Research Ethiopia |
| IITA | International Institute of Tropical Agriculture |
| ISAR | Institut des Sciences Agronomiques du Rwanda |
| KARI | Kenya Agricultural Research Institute |
| MoA | Ministry of Agriculture |
| MSIRI | Sugar Industry Research Institute Mauritius |
| NARI | National agricultural research institute |
| NARO | National Agricultural Research Organisation Uganda |
| NARS | National agricultural research organization |
| NGO | Non governmental organization |

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| OMMN | Organic Matter Management Network, Kenya |
| PABRA | Pan Africa Bean Research Alliance |
| PASOLAC | Programa de Agricultura Sostenible en las Laderas de America Central |
| PNL | Programme National Legumineuses Democratic Republic of Congo |
| REDSO | Regional Economic Development Services Office (of USAID) |
| RESAPAC | Reseau pour l Amelioration du Haricot (*Phaseolus*) dans la Region de l Afrique Centrale |
| SABRN | Southern Africa Bean Research Network |
| SACCAR | Southern Africa Centre for Cooperation in Agricultural Research and Training |
| SADC | Southern Africa Development Community |
| SDC | Swiss Agency for Development and Cooperation |
| UNIBU | Universite National du Burundi |
| USAID | United States Agency for International Development |
| WVI | World Vision International Angola/Rwanda |