Farmers control bean root rot with a blend of science and indigenous knowledge

RIU

Validated RNRRS Output.

African farmers—and women farmers in particular—are using a wide range of integrated management options to protect against bean root rot. Researchers and partners in Uganda, Kenya, Malawi and South Africa are using manuals describing new tools, methods and techniques, and Village Information Centres are helping community members to access appropriate information and technologies. Participatory rural appraisals and surveys of indigenous technical knowledge were combined with sophisticated screening, selection and diagnostic techniques to come up the management components, which are specially designed for use in south-western Uganda, as well as in areas with similar conditions.

Project Ref: **CPP09:**
Topic: **1. Improving Farmers Livelihoods: Better Crops, Systems & Pest Management**
Lead Organisation: **Central Science Laboratory, UK**
Source: **Crop Protection Programme**

Document Contents:

Description, Validation, Current Situation, Current Promotion, Impacts On Poverty, Environmental Impact,

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Description

CPP09

Research into Use
NR International
Park House
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ME20 6SN
UK

Geographical regions included:

Colombia, Kenya, Malawi, South Africa, Tanzania, Uganda,

Target Audiences for this content:

Crop farmers,

A. Description of the research output(s)

1. Working title of output or cluster of outputs.

Bean Root Rot Disease Management

2. Name of relevant RNRRS Programme(s) commissioning supporting research and also indicate other funding sources, if applicable.

DFID Crop Protection Programme

3. Provide relevant R numbers

R7568 (ZA0373)
R8316 (ZA0586)
R8478 (ZA0689)

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NGOs/Networks:
PABRA
World Vision
AFRICARE
CARE

*4. Describe the RNRRS output or cluster of outputs being proposed and when was it produced? **(max. 400 words)**. This requires a clear and concise description of the output(s) and the problem the output(s) aimed to address. Please incorporate and highlight (in bold) key words that would/could be used to select your output when held in a database.*

Projects R7568/R8316/R8478 addressed problems of **soil health** and specifically sought to develop tools and knowledge that could be used as a basis to refine and promote methods for the sustainable control of **bean root rot** (**BRR**) using a combination of scientific and **socio-economic research**. Significant advances in knowledge of the biology of the disease, its causal agents, their epidemiology and interactions with other bean pests and pathogens were achieved. Studies undertaken by international teams focussed on BRR in **Uganda**, but with results having potential for use and to benefit countries (17) under the Pan Africa Bean Research Alliance (PABRA). In order to ascertain farmers' perceptions of the causes of root rots, crop management practices and gain insight into their perception of BRR, **Indigenous Technical Knowledge** (**ITK**) surveys and **Participatory Rural Appraisals** (**PRAs**) were carried out. Healthy and infected cropping situations were compared and a comprehensive collection of primary pathogens causing BRR were isolated and characterised. The distribution of BRR-causing pathogens was mapped. Novel rapid and reliable diagnostic tools for identification, differentiation and quantification of ***Fusarium*** and ***Pythium*** were developed, including **multiplex PCR** techniques for positive identification of main *Pythium* sp. associated with common bean, and a molecular-based quantitative assay. Molecular variation within and between groups of pathogenic and non-pathogenic isolates of ***Fusarium solani* fsp *phaseoli*** (**FSP**) was examined, and pathogen-specific PCR primers were successfully developed. **Integrated Disease and Pest Management** (**IDPM**) strategies for control of BRR appropriate to resource-poor farmers were evaluated, and their effect(s) on pathogen populations and crop yield assessed. Several farmer-managed trials were established in community plots involving six farmer groups (with a total of >100 members). These included participatory variety selection of BRR resistant varieties and fertility improvement using different types of organic amendments. Materials and technology of interest were then selected for use in farmers' individual plots. Acceptance criteria of BRR management technologies that were evaluated within farmer groups were better understood, and formed the basis of scaling-up efforts. Root rot resistance of nearly 500 bean accessions have been quantified in screenhouse trials and in farmers' fields. Over 300 germplasm entries were screened for resistance to *Pythium* root rot under artificial inoculation in a screeenhouse. Accessions in a root rot nursery (68 entries) and a segregating population (110 entries) were screened at the highland NARO station of Kachiwekano. Several potentially valuable accessions have been identified and subjected to further on-farm evaluations. In some cases, resultant germplasm integrated into the programmes of target institutions. Interactions between pathogens causing root rots and other biotic/abiotic factors influencing epidemiology were investigated. A nematode survey revealed slight galling due to **root rot nematodes** (**RKN**) present in many fields, but found no association between BRR and RKN. To assess potentially beneficial disease-moderating relationships between soil organisms, the interactions between 19 different isolates of *P. ultimum* and potential biocontrol organisms (e.g. ***Mortiellera*** *spp*), were evaluated under laboratory/ screenhouse/field conditions. Mortirella (MS10) was observed to have antagonist effects to pathogenic *Pythium* isolates with marked reduction in disease severity and may be utilized as a biocontrol agent for *Pythium* root rot.

The effects of management options on inoculum populations of pathogenic and non-pathogenic species were also assessed. In order to evaluate the significance of other crops in the occurrence of BRR, the incidence and severity of root rots on crops associated with bean as intercrops and/or in rotation have been ascertained. Root rot pathogens were collected from crops in 16 sub-counties of Kabale District, characterised, and their respective pathogenicities established. Several *Pythium* spp were found to be in association with beans and a few were pathogenic to beans, however, *P. ultimum* is the most frequent and pathogenic species in the region in the case of beans and their intercrops. Other crops in the bean system play a role as likely hosts to bean pathogenic *Pythium* spp. The impact of alternative BRR management practices on the productivity of other crops was assessed, allowing a series of recommendations for desirable (inter)cropping practices to be set. Knowledge generated is crucial to formulating an effective management strategy for BRR in systems similar to that in southwestern Uganda. PRAs and ITK surveys identified existing information flow within farming communities, and allowed promotion methodologies suitable for effective technology transfer to resource-poor farmers to be identified. Manuals containing detailed protocols on identification and quantification of FSP and *Pythium* spp. have been developed and disseminated to user groups re. detection and incidence of BRR pathogens.

Outputs from the above projects include numerous datasets, that are fully listed in Project Completion Summary Sheets. Other written outputs include Reports, MSc and PhD Theses, presentations at international conferences, posters, publications in journals and conference proceedings etc.

5. What is the type of output(s) being described here?
Please tick one or more of the following options.

Product	***Technology***	***Service***	***Process or Methodology***	***Policy***	***Other Please specify***
X	*X*		*X*		

6. What is the main commodity (ies) upon which the output(s) focussed? Could this output be applied to other commodities, if so, please comment

The main commodity upon which the above outputs were focussed was beans (*Phaseolus vulgaris*). However, valuable tools (cultural and molecular) for identification and quantification of FSP and *Pythium* spp have been developed in projects R7568, R8316 and R878, and it has been shown that some of the *Pythium* species causing root rots in beans also affect other crops (e.g. sorghum, millets and peas) often grown in association or in rotation with beans. This means that people/organisations who are likely to be interested in information, methods, and techniques developed for *Pythium* are therefore not only limited to researchers working on beans, but may include researchers working on other crops affected by *Pythium* pathogens in the PABRA region. Strategies to improve soil health developed in these projects will benefit other crops intercropped or grown in rotaion with beans. The major additional commodities grown in complex Ugandan cropping systems include sorghum, maize, sweet potatoes, Irish potatoes, bananas and peas. Other crops grown on a small scale by selected households included sugarcane, pineapples, passion fruit, yams, pumpkin, cabbages, cassava, tomatoes, carrots, onions, avocado and coffee.

7. What production system(s) does/could the output(s) focus upon?
Please tick one or more of the following options.
Leave blank if not applicable

Semi-Arid	***High potential***	***Hillsides***	***Forest-Agriculture***	***Peri-urban***	***Land water***	***Tropical moist forest***	***Cross-cutting***
	X	*X*					

8. What farming system(s) does the output(s) focus upon?
Please tick one or more of the following options (see Annex B for definitions).
Leave blank if not applicable

Smallholder rainfed humid	***Irrigated***	***Wetland rice based***	***Smallholder rainfed highland***	***Smallholder rainfed dry/cold***	***Dualistic***	***Coastal artisanal fishing***
			X			

9. How could value be added to the output or additional constraints faced by poor people addressed by clustering this output with research outputs from other sources (RNRRS and non RNRRS)? (max. 300 words).

Please specify what other outputs your output(s) could be clustered. At this point you should make reference to the circulated list of RNRRS outputs for which proformas are currently being prepared.

Since the projects described above aimed to address the problems of soil health, they could be linked with other RNRRS addressing soil health for example, R8449/R8212 *Promotion and dissemination of Integrated Pest and Soil Fertility Management strategies to combat striga, stemborers and declining soil fertility*. In addition, our outputs are strongly linked to CPP project R7965 *Scaling up and scaling out bean IDPM promotion activities including pest tolerant and improved high yielding bean genotypes.* They also have potential links with CPP projects: R8415 *Dissemination of improved beans*, and project cluster: R8414/R7965/R7568/R7569/R8316 *Promotion of bean ICPM*. Outputs tie in with other bean research in Africa through PABRA*, East and Central African Bean Research Network (ECABREN), Southern Africa Bean Research Network (SABRN) over-arching initiatives (through PABRA), CIAT and other donors (Canadian International Development Agency (CIDA), Southern African Development Community (SADC), US Agency for International Development (USAID) and Rockefeller Foundation). In addition, they link with the Rural Innovation Activities/Beyond Agricultural Production to Poverty Alleviation (BAPPA) initiative that is managed by CIAT, and implemented through NGOs: AfriCare in Uganda, Concern Universal in Malawi, and a local NGO in Tanzania. In addition, the work links with the African Highlands Initiative (AHI) in Uganda.

*Related projects progressed under PABRA:

Identification of new sources of resistance (CIAT)

- Evaluation of Regional Root Rot Nursery (KARI, NARO, Institut des Sciences Agronomique de Rwanda (ISAR), Democratic Republic of Congo Institut National pour l'Etude et la Recherche Agronomique (DRC-INERA), CIAT)
- Studies on the reaction of varieties tolerant of low soil fertility to root rots and vice versa (DRC-ECABREN sponsored)

Investigations into mechanism(s) of inheritance of resistance (CIAT)
Improvement of resistance of local cultivars (ECABREN, CIAT)
Herbaceous legumes as sources of green manures (KE/AHI)
Interactions between nematodes, BSM and Fusarium wilt (DRC-ECABREN sponsored) (DRC- INERA)
An investigation into the nature and inheritance of resistance in G685 against Fusarium wilt (CIAT/ISAR – in Rwanda)
Improving resistance of G2333 against Fusarium wilt (CIAT in Rwanda)
Technology transfer of some of the tested IDPM components (varieties; soil fertility management) (ISAR, KARI, NARO & NGOs)
Evaluation (on-farm/station) of IDPM components (ISAR, KARI, NARO, CIAT, DRC-INERA)

The *Conservation and Sustainable Management of Below-Ground Biodiversity* (CSM-BGBD) project, (CIAT, co-financed by the Global Environment Facility (GEF)), aims to generate knowledge that can be used to conserve BGBD in tropical agricultural landscapes, and is thus be an ideal partner in the promotion of outputs generated in R7568/R8316/R8478 (see response to Q. 16, below).

Validation

B. Validation of the research output(s)

*10**. How** were the output(s) validated and **who** validated them?*
*Please provide brief description of method(s) used and consider application, replication, adaptation and/or adoption in the context of any partner organisation and user groups involved. In addressing the "who" component detail which group(s) did the validation e.g. end users, intermediary organisation, government department, aid organisation, private company etc... This section should also be used to detail, if applicable, to which social group, gender, income category the validation was applied and any increases productivity observed during validation **(max. 500 words)**.*

- Validation of characterised germplasm and fertility improvement practices were undertaken through farmer-managed on-farm trials. Several farmer-managed trials were established in community plots involving 6 farmer groups (>100 members). These included participatory variety selection of root rot resistant varieties (including entries of the root rot resistant (RRR) nursery), segregating populations and fertility improvement (organic and inorganic soil amendments). Materials/technology of interest were then selected for use in farmers' individual plots. Of the 68 entries in the RRR nursery, several entries were more resistant than the rest and were selected (on the basis of farmer criteria) for further evaluation. Selected entries were subsequently grown on communal plots to multiply seed, and also on individual farmer's plots. Following participatory evaluations of technologies in both group and individual fields over two seasons, assessment of acceptance of technologies was made between November 2002 and Febuary 2003, through group discussions and informal interviews.

- Validation of the quantitative assay developed for key *Pythium* spp was not completed within the project duration. However, a standard curve for the estimation of *P. ultimum* oospores in soils was developed based on the ratio between target DNA (obtained from known numbers of oospores) and control (competitor) DNA. Sterile field soil spiked with different concentrations of *P. ultimum* oospores was used for the development of the standard curve. The project team are still in the process of testing the suitability of the designed competitive PCR assay for direct estimation of *P. ultimum* propagules directly in the soil. Several procedures for direct extraction of *P. ultimum* DNA from soils are currently being tested, by extracting DNA from known concentrations of *P. ultimum* oospores spiked into soils differing in clay, humus and organic matter content, so as to optimize the conditions under which this assay could be applied for the the estimation of *P. ultimum* propagules directly in soil.
- In order to validate protocols developed under R7568/R8316/R8478, manuals have been circulated to a variety of collaborators to ensure that these documents will function and that procedures listed are reproducible under different environmental conditions and settings. Information has been shared with BGBD project (hosted by the Tropical Soil Biology and Fertility Institute (TSBF) of CIAT).
- Adoption and impact studies, following uptake of IDPM outputs, have been undertaken in Southwestern Uganda, thus validating crop management practices advocated in R7568/R8316/R8478. (For further details, see response to Q. 20)

*11. **Where and when** have the output(s) been validated?*

*Please indicate the places(s) and country(ies), any particular social group targeted and also indicate in which production system and farming system, using the options provided in questions 7 and 8 respectively, above **(max 300 words)**.*

- Accessions in the RRR nursery, and a segregating population, were screened at the NARO station of Kachiwekano, Uganda.
- Validation of protocols on identification and quantification of *Fusarium* and *Pythium* species is not only taking place in Uganda, but also in Kenya, Malawi and South Africa, where manuals have been distributed to to bean researchers and partners.
- Adoption and impact studies re. project outputs were conducted at project sites in Uganda, and also in Kenya and Tanzania, where farmers and farmers groups have been made aware of bean IDPM project outputs. Specific sites were Kabale district in South Western Uganda, Kisii and Rachuonyo districts in Nyanza province, Kenya, and Hai district in northern Tanzania. In Uganda, all participants were moderately poor endusers, farming hillside/highland periurban African smallholdings. Both men and women took part (see above). In Uganda, bean IDPM technologies were introduced in Kabale district in 2001, and the impact study was done in August 2005.

C. Current situation

*12. **How and by whom** are the outputs currently being used? Please give a brief description **(max. 250 words**).*

- The main beneficiaries of the outputs are the smallholder farmers, initially in Uganda, but ultimately throughout the ECABREN region. IDPM outputs are currently being used by bean farmers in Southwestern Uganda. In addition to this, through the combined efforts of CIAT/NARO/DFID project teams, many bean farmers in Kenya and Tanzania have been made aware of IDPM technologies developed in R7568/R8316/R8478. The projects were gender sensitive, so outputs generated are of benefit to and are being used by both men and women, although women were particularly targeted as beans are a "women's crop".
- Manuals produced during R7568/R8316/R8478, detailing protocols on identification and quantification of FSP and *Pythium* spp, to facilitate wider utilization of tools, methods and techniques are being used bean researchers and partners in Uganda, Kenya, Malawi and South Africa. Special efforts have been made to adapt and modify these protocols such that they will be useful under the sub-optimal conditions found in most National Agricultural Research Systems.

*13. **Where** are the outputs currently being used? As with Question 11 please indicate place(s) and countries where the outputs are being used **(max. 250 words).***

- The information gathered and technologies developed in these projects are not only being used by researchers in the Bean programmes in Uganda, but also other ECABREN countries. IDPM outs are in use in Uganda, and also in Kenya and Tanzania, where farmers and farmers groupshad been made aware of bean IDPM project outputs. Specific sites were Kabale district in South Western Uganda, Kisii and Rachuonyo districts in Nyanza province, Kenya, and Hai district in northern Tanzania.
- Protocols developed are being used for Marker Assisted Selection (MAS) in breeding programmes for Angular Leaf Spot (ALS) and *Pythium* root rot at Kwanda Biotechnology lab and CIAT Colombia, as well as by other collaborating ECABREN countries.
- Diagnostic manual for *Pythium* and *Fusarium* spp have been shared with BGBD Project (TSBF, CIAT), as well as students and partners from Kenya, Uganda, Malawi and South Africa, and other researchers (e.g. TSBF) in other countries (Kenya and South Africa). The manuals will be published (and distributed) when all components are ready.

*14. What is the scale of current use? Indicating how quickly use was established and whether usage is still spreading **(max 250 words).***

- The CIAT/NARO/DFID socio-economic impact study revealed that a wide range of IDPM outputs are now being used by farmers/farmers groups in Southwestern Uganda. These include use of soil amendments (Farm Yard Manure (FYM), compost and green manure, inorganic fertlisers), improved bean varieties, soil and water conservation measures, as well as other recommended agronomic practices. The scale (measured as % survey respondents utilising technologies) at which these have been adopted for purposes of controlling BRR are as follows: Application of compost manure (46%); Use of improved varieties (8%); Use of FYM (64%) Planting in lines (15%); Digging trenches & stabilizing bunds with agro-forestry trees and grasses (22%). The extent to which outputs have been adopted is related to availability of materials/resources, and also well the beneficiaries understand the accruing returns. Technologies, whose returns beneficiaries are confident about, have been adopted to significant levels with clear sustainability plans. Those technologies that require extra resources or those of which beneficiaries have relatively little previous knowledge, have been adopted on a more limited scale. Generally, technologies were being implemented in an integrated manner as opposed to single interventions.

A Village Information Centre (VIC) is a new venture that is being pioneered with support from CIAT and NARO in Southwestern Uganda, in collaboration with a Modified Farm Field School (MFFS) at Nyamabaale. The VIC is intended to help community members access agricultural information and technologies, and will thus further promote and spread usage of project outputs.

- The use of protocols/manuals is limited because some Partner countries lack the basic facilities needed to carry out molecular studies (although the Kwanda laboratory has capacity to take on their activities).

15. In your experience what programmes, platforms, policy, institutional structures exist that have assisted with the promotion and/or adoption of the output(s) proposed here and in terms of capacity strengthening what do you see as the key facts of success? ***(max 350 words).***

Collaboration between partners such as NARO, PABRA, NGOs (e.g. AHI), overseas collaborators and other extension services has been instrumental in the success of projects R7568/R8316/ R8478. Involvement of policy makers (government and political leaders), who increasingly participated in dissemination and promotion activities by exchanging ideas with farmers and changing policy issues related to agricultural production, also greatly contributed to the extent of adoption. The establishment of a MFFS stands out as an appropriate capacity building tool that is enabling detailed-learning among beneficiaries, resulting into empowerment in terms of knowledge and skills. Key indicators of empowerment among IPDM groups include enhanced capacity to test, adopt and disseminate appropriate innovations, the confidence with which group members mobilized communities, handled training events and influenced decision-making within and outside their communities. Equally important is the ability to articulate their service demands and networking with other SPs. Group members are becoming resource persons in their communities and some have been elected into leadership offices. Unlike other approaches, the MFFS enhances ownership of technologies and offers opportunities for sustainability. Compared to other approaches, the MFFS from the start focused on a specific enterprise (beans), which was done in great detail giving beneficiaries a chance to closely follow up various trends – learning, adoption and dissemination and, they are thus better able to think through the future.

Current Promotion

D. Current promotion/uptake pathways

16. ***Where*** *is promotion currently taking place? Please indicate for each country specified detail what promotion is taking place, by whom and indicate the scale of current promotion* ***(max 200 words).***

Projects R7568/R8316/R8478 have underpinned the community-based seed-production initiatives developed/promoted by NARO and CIAT, and also link with the National Agricultural Advisory Services (NAADS), a recent initiative in Uganda utilising new approaches to extension delivery to make it more effective. NAADS's mission is to increase farmer access to knowledge and technology for profitable agriculture. NAADS have activities in southwest Uganda, where these projects were also based. Project R8478 also linked with the RIA/BAPPA initiative, managed by CIAT and implemented through NGOs: AfricCare in Uganda, Concern Universal in Malawi, and a local NGO in Tanzania. Methodologies MoUs have been developed with these organisations. Under BAPPA, CIAT's role is to develop and promote the process with the NGOs who seek to address organisational capacity, farmer experimentation, social capital, environment and women's empowerment. Manuals (see above) for cultural and molecular identification/quantification of key root rot pathogens are being validated by/promoted through the BGBD Project (TSBF, CIAT). Promotion of project outputs was/is also achieved in parallel with those technology-evaluations that use participatory approaches in community fields, since these also serve as demonstration plots. In order to build on beneficiaries' indigenous/cultural knowledge, BRR management interventions combining tolerant varieties, soil fertility improvement measures and other IPDM strategies have been discussed with partners and experimented by the grass root beneficiaries (innovative farmers) through the MFFS. The VIC, currently under construction, will provide community members with access agricultural information including BRR technologies. It will be stocked with reading materials in popular version and community members will promote the centre through radio announcements, local newspapers, schools and places of worship. More sensitisation will be done during training sessions (i.e. group members training other groups), to be held at the VIC.

17. What are the current barriers preventing or slowing the adoption of the output(s)? Cover here institutional issues, those relating to policy, marketing, infrastructure, social exclusion etc. ***(max 200 words).***

Practical barriers include:

- Environmental factors: In Kisoro district (Uganda) there is no readily available method of soil fertility improvement. Land shortage means that crop rotation is not a popular option and due to lack of grazing, the livestock population is too small to provide significant amounts of manure. Under these specific circumstances, the use of improved bean varieties, rather than soil amendments, would be most practicable;
- The use of protocols is limited because some Partner countries lack the basic facilities needed to carry out molecular studies;

Social barriers:

- Social differences – wealth, age and education level. If a trainer is perceived as being of a lower social status than his/her trainees, then he/she will be despised;
- Unrealistic learner expectations – historically, NGOs provided participants with handouts/inputs and/or a meal during training sessions. People still expect "rewards" for coming to learn;
- Inadequate community/group cohesion;
- Unwillingness to work;

- Poor community mobilisation;
- Low literacy levels of beneficiaries;
- Few extension workers within a large area of jurisdiction;
- Lack of good market;
- Inadequate inputs and tools;
- Lack of supportive policies;
- Poor/bad leadership – if a leader does not support a programme, it will fail. Political interference by local leaders also impedes uptake;
- Limited access to service providers;
- Funding issues – including misuse of funds, poor financial accountability, and failure of groups to co-fund as required by Government programmes;
- Limited enterprise selection for technologies being assessed.

*18. What changes are needed to remove/reduce these barriers to adoption? This section could be used to identify perceived capacity related issues (**max 200 words**).*

- It is necessary to expand IDPM training content to include savings and credit mobilisation or revolving input fund schemes: Groups need to build capacity to pool savings that can be borrowed by members to access the inputs. Alternatively, a revolving fund could be given by the project, so that its managed by the group, and members borrow from the fund for a specific period of time and then repay. Such a strategy would enable farmers groups to have subsidised access to inputs.
- Where possible, IDPM enterprises should be linked to markets, and the project would facilitate groups to open up linkages with existing government programmes
- Group dynamics and leadership skills need to be enhanced: This would strengthen groups, improving cohesion and enabling them to run their businesses in a more sustainable manner. This would also help them to manage their finances better (see above).
- Information centres should be established, and teaching guides/popular field hand books need to be developed: Teaching guides/field handbooks would provide skills-backup to the groups, while the information centres provide appropriate information in local language. Additionally, groups could identify persons that could be trained, and then remain in the community as reference points.

*19. What lessons have you learnt about the best ways to get the outputs used by the largest number of poor people? **(max 300 words).***

- We learnt that farmers have good understanding of many aspects of root rot disease, based on their observations, but there are aspects that they neither know nor understand (causal agents, predisposing factors, bases of management practices). Therefore, when disseminating knowledge-intensive technologies, farmer field schools represent ideal opportunities for their education, and for improving capacity for the choice/application of management practices. They also provide forums at which to identify appropriate extension materials.
- PRAs identified existing diffusion pathways for dissemination of information/outputs to poor smallholder farmers. These include places of worship, friends, community members, relatives, markets, local farmers groups, newspapers, public notice boards, local council secretaries, local leaders, bars and burial places. By contrast, market places, radio, UNFA, Africare, politicians, seminars, workshops, filmshows and schools were

found to be rarely-utilised. Of all sources identified, farmers groups are most important: when farmers were asked to specify where they had acquired agricultural information in the last 5 years, almost one third named their primary sources as other farmer-group members. Moreover, farmer-farmer-communication networks (relatives, friends, groups, neighbours) are more common than farmer-extension worker or farmer-NGO networks. This testifies to the importance of farmers' groups in the dissemination of technologies, and further supports the use of field schools as particularly valuable starting points for any promotion/uptake network.

- Bean-growing is predominantly a women's job. Women are thus potential assets as adopters of new technologies, and a suitable diffusion pathway since they share more than men. Strategies designed to increase adoption must target women.
- There is a need to solve an existing communication-bias in favour of close relations, in order to realize free technology-flow throughout communities.
- Farmers' access to technologies, through purchase or as donations, is best through farmers' groups, the village administrative unit and the Sub-county administrative unit.
- It was clear that building on existing groups is better than pioneering new groups. In general terms, old established groups have experiences various evolutionary stages, are thus more organised, and have focussed activities. It is logical to conclude that factors such as collaboration with other partners and organisational capacity enhance the performance of a well-established group.

Impacts On Poverty

E. Impacts on poverty to date

20. Where have impact studies on poverty in relation to this output or cluster of outputs taken place? This should include any formal poverty impact studies (and it is appreciated that these will not be commonplace) and any less formal studies including any poverty mapping-type or monitoring work which allow for some analysis on impact on poverty to be made. Details of any cost-benefit analyses may also be detailed at this point. Please list studies here.

- A formal socio-economic impact study "*Findings of the socio-economic impact study of the CIAT/NARO/DFID IPDM Project, Kabale district, Southwestern Uganda*" (Edidah Ampaire Lubega) was conducted to assess how the adoption of IPDM innovations introduced in Kabale district (Buhara and Rubaya sub-counties) through the combined outputs of CIAT/NARO and /DFID projects since 2001, had influenced the livelihoods of beneficiaries. The study also examined farmers' knowledge of BRR, its management practices and how the IPDM technologies were diffusing into the communities. The study was further intended to analyse and compare the different approaches that researchers and development workers use in disseminating IPDM technologies with particular emphasis on beans. Random and purposive random sampling methods were used to gather primary and secondary data (analysed using SPSS). Formal questionnaires were administered during interviews with individual farmers. Check lists and semi-structured discussions were used to solicit information from focus groups, key informants (local leaders, members of partner programmes/NGOs) and individual farmers. A formal questionnaire was administered to 100 Ugandan farmers (53 men, 47 women) with hands-on-experience in bean production. Data were analyzed using the SPSS statistical computer package. (In addition to assessing impact in Uganda, In northern Tanzania, where over 6,000 farmers have also been made aware of bean IDPM technologies, 236 individual bean farmers took part in the socio-economic impact study (114 men, 122 women). In Kenya, 61 farmers (25 men, 36 women) out of 4,000 farmers participated).

- Although not a formal assessment of impact, an ethnographic study, conducted between September and November 2000, obtained comprehensive data that will subsequently allow for furter future impacts on poverty to be made following full uptake of outputs/technologies developed in R7568, R8316 and R8478. Specifically, this study targetted “knowledgable” farmers’ groups who conducted a wealth ranking exercise for all households in villages in the study communities (>100 individuals). Detailed information was obtained on social organisation, land tenure and ownership, settlement and marriage patterns, values and beliefs, as well as on the major crops being grown. Wealth indicators were: amount of land owned, type of labour used, sources of income/other resources, house construction materials utilised, level of education, food availability and access to health services. Wealth category lists were subsequently drafted for 3 villages from 2 districts of Uganda (Kabale and Kisoro, respectively). Participants were from the highly-populated Kafunjo and Karambi Parishes.

21. Based on the evidence in the studies listed above, for each country detail how the poor have benefited from the application and/or adoption of the output(s) ***(max. 500 words):***

- *What positive impacts on livelihoods have been recorded and over what time period have these impacts been observed? These impacts should be recorded against the capital assets (human, social, natural, physical and, financial) of the livelihoods framework*

Generally, the practical sessions used in implementing project activities have helped to empower men and women farmers in the management of their resources. Skills of individual farmers and groups in the identification and management of production constraints (such as disease, insect pests, soil fertility and markets) have been improved. In addition, farmers’ confidence in the effectiveness of indigenous practices has been built and they can now incorporate them into improved technologies. Specifically, in Uganda, bean IDPM technologies were introduced in Kabale district in 2001, and the impact study was done in August 2005. In terms of affecting livelihoods, there has been increased food production at household level, group members reported increased household incomes and disadvantaged groups (women, the elderly and youths), who belonged to groups, were able to access learning and acquire skills. There has been an overall change of attitudes from upholding traditional beliefs and rituals to believing proven scientific facts. Men have become more cooperative with women in relation to land use decisions and there has been increased male participation in bean production. Thirty two percent of responses indicated that beneficiaries had acquired free agro-inputs (chemicals, fertilisers, and high-yielding improved seed), 30% had acquired new knowledge and skills about improved technologies, 22% had realised increased production, 9% had realised increased incomes, 12% freely shared information, and 7% had learnt group dynamics.

- *For whom i.e. which type of person (gender, poverty group (see glossary for definitions) has there been a positive impact*;

Both men and women have benefited. However, impact on women and the elderly has been especially marked. The participation of women in the promotion of IDPM technologies (training sessions, on-farm trials, visits etc.) has helped them gain recognition and publicity from farmers and stakeholders from within and outside the community. The confidence of participating women has improved substantially in all groups. The studies revealed that a number of women farmers were holding leadership positions in different groups, and they were being selected to attend training sessions and seminars to improve the performance of their groups and the community at large. Leadership in the research groups has helped women to have confidence in discussing different issues, especially those concerning household and community development.

- *Indicate the number of people who have realised a positive impact on their livelihood;*

Over 50,000 well-trained farmers have evolved at project sites in Uganda.

- *Using whatever appropriate indicator was used detail what was the average percentage increase recorded;*

Adoption rates for environmentally friendly options for ISFM and IDPM are as high as 86.7% and 85% respectively in two pilot sites in Uganda. Farmers who took part in the CIAT/NARO/DFID socio-economic impact study gave the following quantitative indications as to how adoption of project outputs had positively affected their productivity:

Technology/output adopted	**How the technology has helped (% respondents)**
Application of compost manure	Increased production (26%), soil fertility improvement (6%), reduced disease (5%), cheap (4%) tasty bean leaves, controlled BSM
Use of improved varieties	Increased yield (4%)
Use of FYM	Increase yields (37%), increases soil fertility (8%), cheap (6%), controls pests/diseases (4%)
Planting in lines	Use less seed (3%), get high yield (5%) and reduced time in weeding & harvesting
Digging trenches & stabilizing bunds with agro-forestry trees and grasses	Stops erosion (3%), controls floods (9%) provide stakes, firewood and animal fodder & improves soil fertility

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Environmental Impact

H. Environmental impact

24. What are the direct and indirect environmental benefits related to the output(s) and their outcome(s)? ***(max 300 words)***

This could include direct benefits from the application of the technology or policy action with local governments or *multinational agencies to create environmentally sound policies or programmes. Any supporting and appropriate evidence can be provided in the form of an annex.*

- Direct – Increased use of resitant germplasm and higher yields will mean that less land is required to grow the same amount of food. This will help to reduce environmental degradation in the region.
- Indirect - Improved cultural strategies will also help to reduce environmental degradation in the region. To date, new environmentally friendly options for managing soil fertility, pests and diseases have been developed, disseminated and adopted. This has subsequently led to: increased soil fertility through increased nutrients in the soil and increased pH for acid soils, reduced root rot infection, increased bean yields, decreased disease incidences and epidemics, and reduced use of chemicals for pest, disease and weed control.

25. Are there any adverse environmental impacts related to the output(s) and their outcome(s)? ***(max 100 words)***

- Soil amendment studies in the screen house and the field showed that applications of farmyard manure can produce large increases in bean crop yield. However, these applications also increased inoculum levels of *F. solani* in the soil. This means that while the use of farmyard manure may be able to compensate for the negative impact of increased disease by causing a good increase in soil fertility, it could still store up potential problems for the future in the form of increased pathogen numbers.
- Increased productivity of farms may be associated with bigger farms that, in turn, may translate into landscape change and reduced biodiversity. Also, there is potential for a concomitant increase in demand for water for irrigation purposes.

26. Do the outputs increase the capacity of poor people to cope with the effects of climate change, reduce the risks of natural disasters and increase their resilience? ***(max 200 words)***

Not directly applicable to these outputs. However, increased productivity on farms, leading to improved nutrition and incomes will, in turn, increase endusers health thus reducing vulnerability to HIV and other diseases.
