



Final Report

Grant Number 2008 PASS 023

Project title: Masters in Crop Science (Plant Breeding Option) for Rwanda and Ugandan Nationals based at Makerere University

By

Dr. Richard Edema (**Project Coordinator**)

Period Covered by this report
1st May, 2008 to 31st May, 2010

Submitted May 30th, 2010

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Executive summary

This is the final report of a two year project (**Grant Reference 2008 PASS 023**) which started in May 2008. This project was developed in response to the critical need for well-trained plant breeders in Rwanda and Uganda. A total of eleven students (one with partial funding) were supported through this grant. These included **nine (9) male and two (2) female**. These students were admitted to the new M.Sc. program in Plant Breeding and Seed Systems in Makerere University that has provided improved quality of training over that which most individual African universities can provide.

This program includes the benefits of an improved curriculum and the advantages of students studying locally over going to Europe or USA. The benefits include lower cost, better retention of graduates in the region, relevant instructional focus and context, research projects that provide benefit to the region, establishment of lasting connections between students from various countries, and maintenance of the students' institutional and family ties.

All students were embed in active breeding programs to enable the students participate in a broader range of training activities. But more so to enable students' thesis research work to directly contribute to ongoing research efforts that combine scientific discovery with economic impact. This process allowed students to directly learn from experienced scientists and technicians in plant breeding programs as well as link to commercial seed companies. This dual experience from both public and private plant breeding operations exposed as well as in built capacity of these students for jobs in both public and private bodies.

The key achievements of this project are:

- a. Successfully trained 11 M.Sc. students within relatively short periods of time. Most of our students are expected to complete and submit their theses between June and October, 2010. This is exactly two years of training, unlike in the regular programs where students have often taken close to 3 years before completion.
- b. Improvement of the University's supervision culture as a result of good design implementation plans, close monitoring of both student and supervisors and provision of financial incentives.
- c. Introduction of a flexible training system that accommodates foreign students with special language problems and initial weaknesses in subject matter by running remedial english and technical classes.
- d. Mobilization of University, NARS, and regional and international capacity to collaboratively train graduate students. This involved visiting lectureships and use of research facilities within and outside the country. This has provided fertile ground for partnerships.

- e. Recruitment of students from Rwanda and Uganda, plus others (Burundi, Kenya, Sudan, Zambia, Zimbabwe and Malawi) has enabled cultural and educational mixing. This in turn has allowed creation of long term partnership, networks, mentors and collaborators (Researchers and institutions)
- f. Improvement of training infrastructure at Makerere University, e.g., acquired TEAL, improved internet connectivity, and purchased appropriate text books.
- g. Importantly, the project has triggered long term changes in the University curriculum and handling of foreign students.
- h. The project enhanced improvement of interaction among University faculty from Kenya (Kenyatta University), Zimbabwe (Africa University) and South Africa (University of Kwa-Zulu Natal-ACCI) as well as collaboration with others NARS.

A second objective of this project was to strengthen the plant breeding research program at Makerere University by repairing and refurbishing key infrastructure required to run an effective breeding program. These were (1) a seed storage facility and (2) a sprinkler irrigation system. These have now been rehabilitated which has bolstered our graduating training capacity.

This project has, therefore, successfully achieved its objectives, which were to:

- a. provide advanced training for a Masters in Crop Science degree (plant breeding option) for up to ten (10) students from Rwanda and Uganda.
- b. strengthen the plant breeding research program at Makerere University through establishment of required facilities such as cold seed storage and an irrigation system.

In addition, the project has catalyzed change in the conduct of postgraduate training, and has ably demonstrated that it is possible to offer high quality and relevant graduate training in an African University.

Annexes

- Annex 1: M.Sc (Plant Breeding and Seed Systems) Students Supported under the AGRA/ PASS project Grant 2008 PASS 023
- Annex 2: Master of Science in Plant Breeding and Seed Systems at Makerere University (Course curriculum)
- Annex 3: Thesis titles and expected completion dates of eleven M.Sc (Plant Breeding and Seed Systems) Students Supported by the PASS Project 2008 PASS 023 at Makerere University
- Annex 4: Titles of Poster and Oral Presentation made by the students during the PASS grantees' meeting in Bamako, Mali, 5-8 October 2009.

Background

Agriculture still plays a crucial role in the livelihoods of people of Rwanda and Uganda. This is estimated to be about 40% and 33% of GDP in Rwanda and Uganda, respectively (World Bank, 2005). Unfortunately about 60% of the population in Rwanda lives below the poverty line and 10-12% of the population suffer from food insecurity every year. Similarly, in Uganda 80% of the population is involved in agriculture and about 44% live below poverty line.

The challenge for these two countries is to at least double and/or preferably triple food production by the year 2050 to meet the needs of the rapidly growing population. Compounding the problem, this additional food will have to be produced on the existing area, or less, of agricultural land (Clive, 1997). Small-scale farmers predominate agricultural systems in these two countries but are faced with increasing population pressure, food insecurity, very low (and declining) levels of agricultural productivity and rapid natural resource degradation (UNDP, 2007).

The stagnation in agriculture is the root cause of poverty in these two countries. Unfortunately, the required human capital to spur agricultural development is lacking in almost every area of agricultural research. For example, a key requisite for addressing food security is to ensure availability of high yielding adapted to local conditions. There is particularly very limited capacity of high level trained plant breeders in Rwanda and Uganda. This is evident in not only the declining student numbers offering plant breeding at university but also the aging research staff in various institutions in these countries. Clearly enhancing productivity will require human capital investment and support for national plant breeding systems. But maintaining human capital requires an on-going commitment to training. Young researchers are needed to replace those who retire, move on to other employers or otherwise leave their research institutions. For example, the National Agricultural Research Organization (NARO) in Uganda has had problems with staff turnover; in 1999 there were about 250 full-time equivalent (fte) researcher scientists in NARO and by mid 2001 researcher numbers had dropped to 170 (Cook and Chema 2001). A similar situation exists in Rwanda which has experienced strong declines in total fte researcher numbers in the 1990s due to civil war.

As an urgent response to the critical need for well-trained plant breeders in Rwanda and Uganda, the Alliance for a Green Revolution in Africa (AGRA) has supported a M.Sc. training program in Plant Breeding for the last two years (2008/2010) at Makerere University. This M.Sc. program has been developed as a regional program involving students and short-term lecturers from within and outside Uganda with partnership with the Regional Universities Forum for Capacity Building in Agriculture (RUFORUM).

Through **Grant 2008 PASS 023**, AGRA helped support the creation of a training platform to efficiently and effectively train mid-career level scientists who will meet

the immediate need for strengthening crop improvement in both the public and private sector in Rwanda and Uganda. These two countries require strong national plant breeding programs.

Specifically, this project:

1. Provided advanced training for a Masters in Crop Science degree (plant breeding option) for up to ten (10) students from Rwanda and Uganda.
2. Strengthened the plant breeding research program at Makerere University through refurbishment of **Cold Seed Storage** and a **Sprinkler Irrigation System**.

A total of **USD 400,000** was provided to support the activities of this project. In the subsequent sections, a summary of the project activities and achievements for the entire period of funding, i.e., from **May 1st, 2008 to May, 31st, 2010** are described.

Starting point of the project

The first instalment of funding for this project was sent to Makerere University on **15th May, 2008**. This allowed Makerere University to initiate the activities of this project starting with recruitment of students, and technical assessments on needed repair for the Seed Store and Irrigation system.

Student Program

Recruitment

The project solicited for good candidates through an aggressive advertisement on notice boards, e-mail contacts and phone calls to key target NARs institutes. For Rwanda, this was done through our collaborating partner at ISAR, **Dr. Claver Ngaboyisonga**. The PI also visited ISAR head quarters for meetings with the Director General and some of the prospective students. Done this way, we were able identify excellent candidates with good prospects of immediate employment when they finally return. As it turned out, many of these were ISAR staff who required up-grading.

In Uganda, the result of the solicitation was a large number of qualified respondents, from which six candidates were eventually selected. All applicants were evaluated by members of staff of the host Department of Crop Science. The six students selected included; four (4) male and two (2) female.

In addition, the project partially supported one other student, Geoffrey Onaga, who was admitted in the Masters of Science (Crop Science) in 2007. Geoffrey is a research assistant with the rice program at the NaCRRI but did not have adequate funding to complete his degree program. The project agreed to support him on a special request from the Cereals' program to help boost its rice breeding activities; at the moment there is only one senior rice breeder (Jimmy Lamo who has just completed his PhD from

ACCI). Support for Geoffrey was envisaged to bolster and help stabilize the rice program at NaCRRI.

Therefore, in total, eleven (11) students were supported through this project. A bio-data of all students finally selected is provided in **Annex 1**.

Coursework

The students funded by this project officially began coursework on **October 4th, 2008**. This was two months after the official commencement of **2008/2009** University academic year (**Academic years starts in last week of August**). The University management allowed this because it was launching a new Master of Science (Plant Breeding and Seed Systems) program into which all the students were eventually admitted. The students were admitted into this program rather than the regular M.Sc. (Crop Science) after consultation with the **Program Manager EACI**. This new program was much more suited to the needs of the students since it provided core competencies, supporting disciplines, and additional skills such as project planning, social research methods and “soft-skills” – all these are competencies required for the contemporary African plant breeder.

M.Sc. (Plant Breeding and Seed Systems) is a **two** course run as ‘**Coursework and Research**.’ Both theory and “hands-on” application are emphasized. Structured coursework were often supplemented with seminars and hands-on training activities involving appropriate NARIs such as NaCRRI. Private seed companies were used to demonstrate values of entrepreneurial skills. A detailed course description is provided in **Annex 2**.

All the students have successfully completed and passed all courses scheduled for them. These included the following core courses and electives:

Year 1

- i. Core Courses
 - CRS 8101 Applied Agricultural Statistics and Biometry (**3credits**)
 - CRS 8102 Principles of Cultivar Development (**3 credits**)
 - CRS 8103 Plant Cell and Tissue Culture (**2 credits**)
 - CRS 8104 Practical Plant Breeding Methods (**2 credits**)
- ii. Elective Courses
 - CRS 8107 Principles of population & evolutionary biology (**3 credits**)
 - CRS 8108 Social Research Methods (**3 credits**)

Year 2

- i. Core Courses
 - AGE 8201 Graduate Seminars and Research Implementation Skills (**2 credits**)

- CRS 8201 Quantitative and Biometrical Genetics (**3 credits**)
 - CRS 8202 Bio-policy, Bio-safety and Bioethics (**2 credits**)
 - CRS 8203 Seed Science and Seed Systems (**3 credits**)
- ii. Elective Courses
- ABM 8201 Agricultural Marketing and Management (**2 credits**)
 - CRS 8205 Disease Management and Epidemiology (**3 credits**)
 - ABM 8202 Project Planning and Management (**2 credits**)

In total, therefore, the students completed **36 credit units** worth of course in the program designed and presented above. Ideally, a minimum of 30 course credits is required to fulfill the requirements of their M.Sc. program at Makerere University.

Additional lectureships

The M.Sc. (Plant Breeding and Seed Systems) is a unique and rich program which has benefited from the expertise of a number of International Lecturers. Those who have actively taught and mentored our students are;

- i. Prof. Paul Gibson (formerly Adjunct Professor of Plant Breeding at the University of Southern Illinois)
- ii. Dr. Albert Chiteka (Africa University in Mutare, Zimbabwe).
- iii. Prof. Reuben Muasya (Kenyatta University, Kenya)
- iv. Dr. Washington Ochola (Egerton University/ RUFORUM Secretariat)



Figure 1. Prof. Paul Gibson (**right**), Dr. Richard Edema (**PI; centre**) and Damien Shumbusha (**left**) during one of visits to Damien's sweet potato trials at NaCRRRI

These experts have greatly bolstered the capacity of Makerere University to offer high quality, international grade training in Plant Breeding. The project took advantage of the expertise and facilities in the various breeding programs at NaCRRI, the Ministry of Agriculture and various private seed companies. For example, as part of the Seed Science and Seed Systems course, the students visited the National Seed Certification Service at Kawanda and the Victoria Seed Company. In day long class sessions, the students were able to see firsthand how these important institutions operate and the challenges they face.

Students' thesis research

All the students were compelled to do their thesis research embedded in on-going breeding work either at Makerere University or the National Crop Resources Research Institute at Namulonge (NaCRRI), or in one of the field stations of NaCRRI. Two (2) of our students also benefitted from technically backstopping from the regional CIAT bean's program at Kawanda. Another one had technical backstopping from AVRDC Center in Arusha-Tanzania as well as is World Centre in Taiwan. While another visited the BECA biotechnology facility at ILRI-Nairobi. All institutions involved above participated in joint supervision of our students. This collaborative arrangement ensured that students were trained at high academic and practical levels with good grounding in hands-on field and laboratory breeding procedures.

Student research theses will be designed to help answer critical areas in key crops in the respective countries. Emphasis was made on the development of improved planting materials for resource-poor farmers, and researchable gaps for each scientific area of specialization were jointly identified with breeding programs where students were embedded. This way, we directed energies of our student into building on past and/or ongoing breeding work in these key crops. This arrangement also enabled our students cover substantial research ground within a relatively short time. The students' thesis topics, target crops and current status of their work is summarised in **Annex 3**.



Figure 2. Collaboration with NARS (especially NaCRRI) in Uganda was key to the success of the project. *Left.* Dr. Yona Baguma of NaCRRI-Cassava and Prof. Paul Gibson in a light moment during a field visit to

NaCRRI-Namulonge; **Right.** Dr. Geoffrey Asea of NaCRRI-Cereal (**extreme left corner**). Prof. Paul Gibson, Dr. Richard Edema meeting the Rice students at the NaCRRI facility

Figure 3. Part the students' research activities during various seasons at NaCRRI



Innocent Habaruma going through procedures to infect his rice plants with the bacterial blight pathogen in the pathology lab at Makerere University



Sylvia Namazzi briefing Dr. Edema and Prof. Gibson on progress of her



A plot of disease screening boxes used by the beans' students. These are a few of some of the very specialised facilities offered by CIAT to help in *Phythium* root rot resistance identification.



A plot of pepper. One student, Vallence Nsabiya, did his M.Sc thesis research on pepper improvement. His research is laying the ground for major future work on pepper.

Mentorship and enhanced practical training

For a whole semester students were attached to selected senior staff at NaCRRI for a mentorship program. The idea was to enable each student to 'watch and learn' from an experienced hand. It was also to enable the students get a feel for research activities in crops other than their target thesis crops. Various technical staff guided the students on key field and laboratory operations in crop improvement and management. At the end of each week a meeting was held between mentor and mentee to share some experiences and lesson learn.



seeing students on a visit to Victoria Seeds Company - such visits were to enable self-entrepreneurships. Putting on a hat is Ms. Josephine Okot, YARA award winner Victoria Seeds Company talking to one of eager student (Maurice Mogga from Southern Sudan, students).

Enhancement of scientific presentation skills and International exposure

Prior to full development of their thesis research areas, the students underwent a week long **proposal/scientific writing** seminar. This was organized in collaboration with RUFORUM. The impact of such a workshop was immediately apparent when students' actually developed their thesis research areas. When these proposals were presented before the Departmental Post-Graduate Committee for vetting, they were all very highly rated.

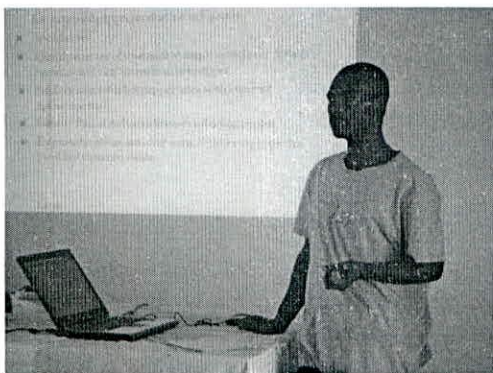


Figure 5. Students had to defend their research proposals before the Post-Graduate Committee of the Department (*left:* Mr. Vallenge Nsabyera from Uganda; *Right:* Mr. Innocent Habarurema from Rwanda)

During the course of their study our student also got opportunity to present their research results in the following International meetings mostly as poster presentation:

1. Program for Africa's Seed Systems (PASS) Grantees' Meeting: The March Toward a Green Revolution in Africa: Improving the Lives of Farmers through Stronger Seed Systems. A Conference jointly hosted by Alliance for a Green Revolution in Africa (AGRA) and the Institut d'Economie Rurale (IER) du Mali Center International des Conferences de Bamako (CICB) Bamako, **Mali, 5-8 October 2009**. All 10 project students participated and presented posters papers (**Annex 4**).
2. International Conference on Agro-biotechnology, Biosafety and Seed Systems in Developing Countries, **8-11 March 2010**, Kampala Uganda. Also all 10 project students participated and presented either oral or poster papers.

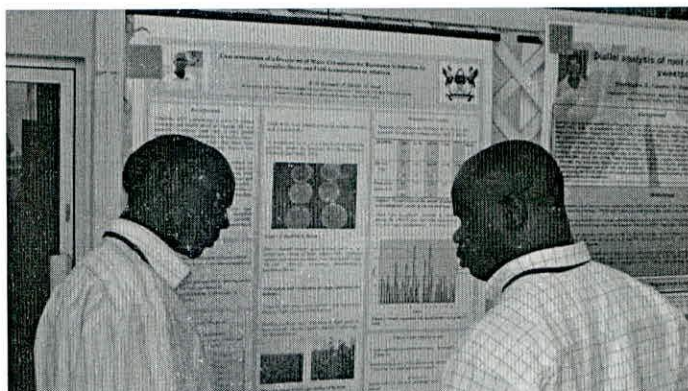


Figure 6. Daniel Kwemoi from Uganda discussing his findings with another participant during the PASS grantee's meeting held 5-8th October, 2009 in



Figure 7. In Mali, we took time to enjoy the excellent Malian culinary with colleagues of ACCI, 2nd left is Prof. Mark Laing, Director ACCI. ACCI could be the next stop for many of the project students!!!

Repair and refurbishment of selected research infrastructure

Our second objective was to strengthen plant breeding research program by repairing and refurbishing key infrastructure required to run an effective breeding program. These were (1) a seed storage facility and (2) a sprinkler irrigation system. We have completed the repair of the cold seed storage and added some equipment for the irrigation system. These are now operational. However, the appropriate personnel to oversee the running of these facilities need to be trained. None of the technicians in the Department is professionally trained to run the cold-store. Repair of the existing generator was abandoned since the damage to the generator was more extensive than initially thought.

Achievements, challenges, opportunities and lessons learnt during implementation of Grant 2008 PASS 023

Achievements:

- We have trained 11 M.Sc. students within relatively short periods of time. Most of the students are expected to complete and submit their theses between **June and October, 2010**. This is exactly two years of training, unlike in the regular programs where students often take more than 3 years to complete their studies. This achieve was possible due to:
 - o Close supervision of training activities by the Project Coordinator.
 - o Recruitment of students in a well structured program that involved local and international staff.
 - o Linking the training and students to a functional breeding program at NaCRRI and other centres.
 - o Provision of skill enhancement course, e.g., scientific writing, data analysis management, mentorship (at NaCRRI and AWARD program) and soft skills
 - o Support and dedication of the resident Senior Breeder, Prof. Paul Gibson
 - o Holding of regular project review meetings
- We have improved the supervision culture as a result good design implementation plans, close monitoring of both student and supervisors and provision of financial incentives.
- We have introduced flexibility to accommodate foreign students with special language problems and initial weaknesses in subject matter by running remedial classes in english and technical subjects.
- We have mobilized the regional capacity for training, involving visiting lecturer, and use of research infrastructure within the Uganda-NARS. This has provided fertile grounds for partnerships

- Recruitment of students from Rwanda and Uganda, plus others (Burundi and Sudan through the DIFD/FARA funded SCRADA project) has enabled cultural and educational mixing. This we hope has allowed creation long term partnership, networks, mentors, collaborators (researchers and institutions) to support future research and training in Africa.
- We improved some training infrastructure e.g. acquired TEAL, improved internet connectivity, and purchased new and appropriate text books.
- Importantly, the project has triggered long term changes in the University in terms of curriculum and handling of foreign students.
- The project has resulted in a joint University – NARI programme, and strengthened the linkage between Makerere University and NARO, and also with the private seed industry.
- The project involved lecturers from other Departments in the Faculty of Agriculture and, thus promoted both inter- and multidisciplinary training.
- Finally, this project will contribute significantly to strengthening national plant breeding programs, especially in Rwanda (and Burundi and Southern Sudan – with SCARDA support)



Figure 8. Students in this M.Sc program have lived together at the Makerere University Agricultural Research Institute at Kabanayolo (MUARIK); here they learn, dance, play games and work together. 15 It is moments like these that enable creation of life-long friendships needed to help tackle Africa's persistent hunger problems are

Challenges

However, the project also encountered substantial challenges during execution. Some of these are highlighted below:

- There were internal management weaknesses in the university that hampered efficient operation of the project e.g. timeliness of reporting, administrative support to the PI, slow response by the University student issues, very limited and irregular e-connectivity
- The new curriculum is quite intense and heavily loaded, making its execution demanding in terms of programming to accommodate the various lectures and activities
- Inability to send students to home institution for research due to mismatch between what is on ground in terms of on-going research projects, facilities, technical backstopping, resources and students demands, especially in terms of ensuring completion within the 2 year study limit.
- Lack of adequate accommodation facilities for students
- Immigration hurdles which were not anticipated such as requirement for student passes. The University does not have a dedicated office to serve students for this purpose.
- Delayed registration of students since the students started after the regular semester of August 2008.
- Lack of proper orientation of students to the university

Opportunities

Nevertheless, the new and pragmatic approach used during the life of this project has presented excellent opportunities for future training platforms.

- We should be able to utilize regional networks established to increase graduate training as this is helping to increase depth of teaching staff, supervisory capacity and field attachment opportunities for students.
- We expect use returning graduates as 'ambassadors' to promote Makerere University, but also use these graduates to provide feedback to us for self-reflection and evaluation. This will inform our curriculum review, programme implementation and quality control efforts.
- We now have experience and greater capacity to handle diverse groups of students. This has, therefore, increased Makerere's postgraduate training portfolio and it is enabling the University to market itself to attract more students and grants, etc.
- The project, and the M.Sc (Plant Breeding and Seed Systems program) has provided a pipeline or pool for future PhD students of Plant Breeding.

Lessons learnt

- Makerere University needs to familiarize herself with the regional training needs and realities and hence prepare to meet those needs.
- Makerere University needs to build her capacity to handle foreign students by putting in place amenities, flexibility in the system and unit to deal with international students.
- Makerere University needs to market herself aggressively – through good websites, media, and communication / information flow.
- A regional approach to training such as under this project requires more logistics, physical facilities, personnel, administrative structures than what is currently in place at Makerere University.
- Greater collaboration between Makerere University and other actors will enhance the quality and relevance of its training and research programmes and placement of its graduate.
- Makerere University must strengthen the pedagogy skills of its academic staff
- Regular skill enhancement for both staff and students is needed in aspects such as utilization of e-resources to strengthen learning.

Figure 9. Infrastructural improvements made to help cope with an expanded local and international cohort of students. Poor infrastructure is still a serious constraint affecting graduate training at Makerere University

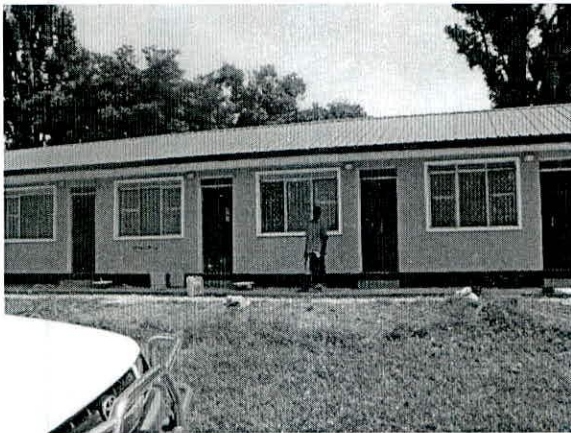


Figure 9. Part of refurbishments made to improve accommodation

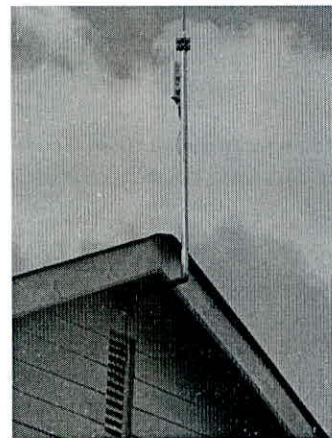


Figure 10. Improving the internet reception using a radio wireless beamer newly installed

Audit of the project by the Internal Audit Unit of AGRA

The Internal Audit of AGRA reviewed the implementation of the project activities of our project from Monday March 29th to Thursday April 1st, 2010. During this visit the IAU team met and discussed project performance with the following people:

1. The Project Manager (PI), Dr. Richard Edema
2. The University Bursar, Mr. Joshua Karamagi
3. The Project Accountant, Mr. Kwesiga
4. Procurement Officer.
5. The 10 students who are sponsored by AGRA for the M.Sc. course.

A report was issued by IUA raising a number of audit concerns that the project needed to address. This has been done and a report separately sent to the Program Manager, EACI.

Final follow-up activities

The project has separately requested a no-cost extension to enable the students to complete their remaining data collection, collations and theses write-ups. The PI together with the student supervisors will help the students submit and defend their theses, and where possible also publish scientific papers.

Acknowledgements

1. The Education for African Crop Improvement (EACI) program of AGRA
2. The Regional Universities Forum for Capacity Building in Agriculture (RUFORUM)
3. The National Agricultural Crop Resources Research Institute (NaCRRI) of NARO- Uganda
4. Kachwekano Zonal Agricultural Research and Development Institute (KAZARDI);
5. International Potato Center – Uganda (CIP)
6. International Center for Agricultural Research (CIAT) - Kawanda
7. Makerere University
8. *Institut des Sciences Agronomiques du Rwanda (ISAR), Kigali, Rwanda*
9. Prof. and Mrs Paul Gibson