

Research Application Summary

**Establishing a Makerere University Regional Centre for Crop Improvement  
(MaRCCI) - an East and Southern Africa Centre of Excellence**

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**Abstract**

Low agricultural productivity in Eastern and Southern Africa has led to recurrent, chronic food insecurity, poor nutrition, and widespread poverty that continues to affect a significant proportion of the population. This low productivity is due to a number of factors key among which include use of unimproved crop varieties; biotic and abiotic stresses; a lack of access to quality seeds, fertilizer, and other inputs; and poor agronomic practices. Conversely, the use of improved crop varieties by Africa's smallholder farmers can substantially boost their production in response to local and international demand for food and nutritional security. However, there is a critical shortage of well-trained crop scientists and plant breeders at graduate level to develop improved crop varieties and their deployment. This is exacerbated by the fact that plant breeding techniques are crop specific and thus, the need for diverse expertise and professionals to address crop improvement challenges for multiple crops and agro-climatic zones in the region. The recently instituted Makerere University Regional Center for Crop Improvement (MaRCCI) will strengthen and expand the two regional (MSc and PhD) programs in Plant Breeding, Biotechnology and Seed Systems. This initiative is to be implemented under the auspices of the African Higher Education Centres of Excellence (ACE II) supported by respective National Governments through a Development Facility from the World Bank. The expected outcomes of the MaRCCI effort include stronger regional Masters and PhD programs in Plant Breeding, Biotechnology and Seed Systems, improved curriculum and delivery, at least 70 highly trained PhD and MSc plant scientists, targeted research that is relevant to the region's agriculture, and a strengthened training and research capacity that serves the wider Eastern and Southern Africa region.

**Key words:** Eastern and Southern Africa, Higher Education Centres of Excellence, Makerere University, plant breeding

## Résumé

La faible productivité agricole en Afrique orientale et australe a conduit à une récurrente et chronique insécurité alimentaire, une mauvaise nutrition, et la pauvreté généralisée qui continuent d'affecter une part importante de la population. Cette faible productivité est due à un certain nombre de facteurs clés parmi lesquels figurent l'utilisation de variétés non améliorées; les stress biotiques et abiotiques; un manque d'accès aux semences de qualité, des engrais, et d'autres intrants; et de mauvaises pratiques agronomiques. Par contre, l'utilisation de variétés améliorées par les petits exploitants agricoles de l'Afrique peut sensiblement augmenter leur production en réponse à la demande locale et internationale pour la sécurité alimentaire et nutritionnelle. Cependant, il y a une pénurie critique de scientifiques agricoles et des améliorateurs génétiques des plantes bien formés au niveau des études supérieures pour développer des variétés améliorées de cultures et leur déploiement. Cette situation est aggravée par le fait que les techniques de sélection végétale sont spécifiques aux cultures concernées d'où la nécessité d'avoir une diversité d'expertise et des professionnels pour relever les défis d'amélioration génétique pour de multiples cultures et des zones agro-climatiques de la région. Le Centre régional pour l'amélioration des cultures récemment institué à l'Université de Makerere (MaRCCI) renforcera et étendra les deux programmes régionaux (MSc et PhD) dans l'amélioration des plantes, la biotechnologie, et les systèmes semenciers. Cette initiative sera mise en œuvre sous les auspices des centres d'enseignement supérieur africains d'excellence (ACE II) financés par les gouvernements nationaux respectifs par le biais d'un mécanisme de développement de la Banque mondiale. Les résultats attendus du MaRCCI comprennent l'amélioration de programmes et d'enseignement des programmes régionaux de niveau master et Doctorat en amélioration des plantes, la biotechnologie et les systèmes semenciers, au moins 70 scientifiques formés au niveau Master et Doctorat, la recherche ciblée qui est pertinente pour l'agriculture de la région, et une capacité de formation et de recherche renforcée qui dessert la grande région Afrique orientale et australe

Mots clés : Centre Africain d'enseignement supérieur d'excellence de l'Université de Makerere, amélioration des plantes

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## Background

The agriculture sector is considered an engine for overall economic development of sub-Saharan Africa (FAO, 2006; African Development Bank, 2010; AGRA, 2016). It contributes 32 percent of gross domestic products and employs about 65 percent of population (FAO, 2006; AGRA, 2016). The current low agricultural productivity in Eastern and Southern Africa has led to recurrent, chronic food insecurity, poor nutrition, and rampant poverty for a significant proportion of the population (World Bank, 2015; 2016). The low productivity is a result of use of unimproved crop varieties; biotic and abiotic stresses; a lack of access to quality seeds, fertiliser, and other inputs; poor agronomic management; and lack of access to profitable markets (AGRA, 2016). A key solution to these multiple constraints is use of improved crop varieties by Africa's smallholder farmers which can substantially boost their

production and productivity in response to local and international demand for food and nutritional needs (DeVries and Toenniessen, 2006).

Growth in agriculture is twice to four times as effective in reducing poverty as other sectors but is held back by a lack of qualified professionals (World Bank, 2015). In Africa, low level of human capital in the agricultural sector remains a significant draw back to growth, poverty reduction, and food security. Unfortunately, higher agricultural education has been neglected for several decades and is poorly prepared to address the need for qualified professionals (Flaherty and Lwezaura, 2010; Flaherty *et al.*, 2010a, b, c; World Bank, 2015; 2016). Moreover, the current agricultural educational system is out of step with the job market (World Bank 2015; 2016). Recently, however, African ministers and leaders have asked for “a radically new approach” to agriculture education. In response, the World Bank in partnership with national Governments designed and started rolling out a unique program to transform higher education. This program dubbed the Higher Education African Centers of Excellence (ACE) has the goal to produce entrepreneurs, creative thinkers and business leaders who contribute to economic growth and poverty reduction (World Bank, 2016).

Only two educational centers of excellence in plant breeding currently exist in the continent, i.e., one in Southern Africa, named the African Centre for Crop Improvement (ACCI) at University of KwaZulu-Natal in South Africa, and the other in West Africa, called the West Africa Centre for Crop Improvement (WACCI) at the University of Ghana, Legon. The total capacity of these two programs is far short of the needed training capacity at the PhD level. The East African Region is in need of such a programme, and can benefit from scaling up a Regional Program in Plant Breeding, Biotechnology and Seed System that exists at Makerere University and is already training for the wider African region (<http://www.ruforum.org/regional-training-program>). This later program currently attracts several students with funding from different agencies, but there is need to improve and strengthen the program.

### **The ACE II Project at Makerere University**

Through the ACE II project, a center of excellence known as the Makerere University Regional Center for Crop Improvement (MaRCCI) has been approved (see: <http://www.universityworldnews.com/article.php?story=2015081214285548>). MaRCCI is hosted at the College of Agricultural and Environmental Sciences (CAES) and is funded as a loan/credit to the Government of the Republic of Uganda. The overall objective of ACE II project is to support the government to strengthen selected Institutions of Higher Education in Uganda to deliver quality post-graduate education and build collaborative research capacity in the regional priority areas.

The MaRCCI builds on two existing regional graduate programs, a PhD in Plant Breeding and Biotechnology (PBB) and an MSc in Plant Breeding and Seed Systems (PBSS; [www.makplantbreeding.org](http://www.makplantbreeding.org)), designed and initiated by Makerere University, and diverse partners namely, the Alliance for a Green Revolution in Africa (AGRA), Regional Universities Forum for Capacity Building in Agriculture (RUFORUM) and others in 2008. Key elements

of the curriculum of these programs include core competencies in basic and applied skills, supplemented by social research methods, management and marketing, as well as a focus on ethics and values. The content of these two programs was developed through a rigorous process under the auspices of RUFORUM, a Network of 60 universities in Africa. The process entailed input from key stakeholders from the private seed industry, the National Agricultural Research Systems (NARIs) in Eastern and Southern Africa and regional and international knowledge centres. This input has: (i) made these programs responsive to problems and future needs in agriculture and society with research and education programs that improve life and preserve environmental quality; (ii) resulted in dynamic and relevant research and academic programs founded in scientific advances and responsive to the needs of students and farming communities in sub-Saharan Africa; and (iii) contributed to successful resource mobilization allowing for effective implementation. In the last seven years, these two programs have trained 120 MSc students ([www.makplantbreeding.org](http://www.makplantbreeding.org)) and 54 PhD students from 25 African countries with thesis research on 15 food-security crops. The MSc program has become established as a premier program, but a lack of funding and other resources have prevented the PhD program from reaching its full potential.

The MaRCCI will revise the existing PhD curriculum to include advances in plant breeding, biotechnology, and seed systems; greatly increase e-based and experiential learning; increase staff; improve facilities; and distance learning. The curriculum will emphasize creative problem-solving and self-learning skills. High-quality student and faculty research will target the economic development needs of each student's home country, and will involve strong coordination between Makerere University supervisors, the student, and a home-institution supervisor. Continuity of research projects will be ensured using a research database that categorizes projects by crop, germplasm, and traits. MaRCCI builds on existing multi-institute cooperation, including industry, regional educational partners, international agricultural research centers, and major United States universities (Table 1). Through the further development of an effective, progressive, and comprehensive training model, MaRCCI has the potential to catalyze a continent-wide transformation in plant breeding and seed systems training.

**Goals and Project objectives.** The overarching goal of the MaRCCI is to expand, strengthen, and transform the PhD (Plant Breeding and Biotechnology) program following the pattern of the highly successful MSc Plant Breeding and Seed System, and to increase coordination between the two programs. Thus, the Center will provide Eastern and Southern African (ESA) nations with industry-ready plant breeders who can use cutting-edge science to develop and deliver new crop varieties. These breeders are urgently needed throughout this region in order to improve food security, nutrition, rural incomes, poverty reduction, and economic development. The MaRCCI will also continue to train for other regions of Africa, including students from outside the continent.

The specific objectives of the MaRCCI are to:

1. Strengthen the training and research capacity in plant breeding, biotechnology and seed systems within the region, and enhance regional and international collaboration.

**Table 1. The key strategic partners of MaRCCI**

Name	Type	Country/Region
<b>USA Partners</b>		
1. Iowa State University	University	USA
2. North Carolina State University	University	USA
<b>Regional partners</b>		
3. World Vegetable Center – Arusha, Tanzania	International Research Center	Global
4. International Center for Tropical Agricultural (CIAT) – Uganda	International Research Center	Global
5. University of Zambia	University	Zambia/Southern Africa
6. University of Juba	University	Republic of South Sudan/East Africa
7. Rwanda Agricultural Board	National Research Institute	Rwanda/East Africa
8. Institut National pour l’Etude et la Recherche Agronomiques (INERA), DR- Congo	National Research Institute	Democratic Republic of Congo/ Central Africa
9. SeedCO, Zimbabwe	Private Business	Continental
10. Biosciences eastern and southern Africa - International Livestock Research Institute (BeCA - ILRI)		
<b>Local partners</b>		
11. National Agricultural Research Organisation, Uganda	National Research Institute	National Research Institute
12. NASECO Seed Company	Private Seed Business	Uganda

2. Improve the content and delivery of Makerere's Plant Breeding graduate curriculum, in order to provide a strong theoretical and scientific foundation with an applied focus on product delivery. The curriculum will serve as a model for ESA universities, and produce graduates that serve ESA private and public sector plant breeding activities effectively.
3. Increase the capacity and sustainability of Makerere University's regional programs in plant breeding, in order to bring expertise together in one place. This will transform the two programs into the premier post-graduate training center of excellence for crop improvement in Africa.
4. Train 26 and 45 new PhD- and MSc- level plant breeders from the ESA region. Some students will be selected for full funding, and others will enroll with part or all of their own funding

### **Expected outputs of MaRCCI**

The *Makerere University Regional Center for Crop Improvement* (MaRCCI) will radically transform two regional graduate programs at Makerere University to implement a menu of novel courses and training approaches. The expected outputs of the MaRCCI by the end of the five year period, supported by anticipated ACE II project funding of USD 6 million, are: Train at least 70 graduate students in PhD (Plant Breeding and Biotechnology) and M.Sc. (Plant Breeding and Seed Systems); Revise and improve curriculum and delivery; Develop short courses to serve industry; Improve efficiency and management of teaching and the ACE program; Improve teaching and research infrastructure; Seek International accreditation; Improve and support a Crop Improvement Research program in breeding at the Makerere University Agricultural Research Institute (MUARIK); Serve as a catalyst for attracting other grant resources to Makerere University; Develop linkage with Industry for output; and Strengthen collaboration in research and training with Regional as well as International partners.

### **Implementation arrangements**

**Guiding rules and regulations.** Makerere University became an independent University in 1970 by Act of Parliament (Act 7). Currently the University operates under the Universities and Other Tertiary Institutions Act of 2001 (As Amended in 2003 and in 2006). These acts provide for the Administration and Standards under which the University operates. In 2006, the Makerere University statute was enacted that enabled establishment of Colleges, Schools, Departments and various Centers.

Under this project the Makerere University Regional Center for Crop Improvement (MaRCCI) will build on Makerere University's relationships with national, regional and international academic partners (Table 1). These partnerships will result in training of industry-ready PhD and MSc-level scientists and practitioners in plant breeding, biotechnology, and seed systems who will receive a quality education that integrates seed and business skills with graduate training in plant breeding. This will set Makerere University's graduates apart from those who do not receive such broad training. The international collaboration will also

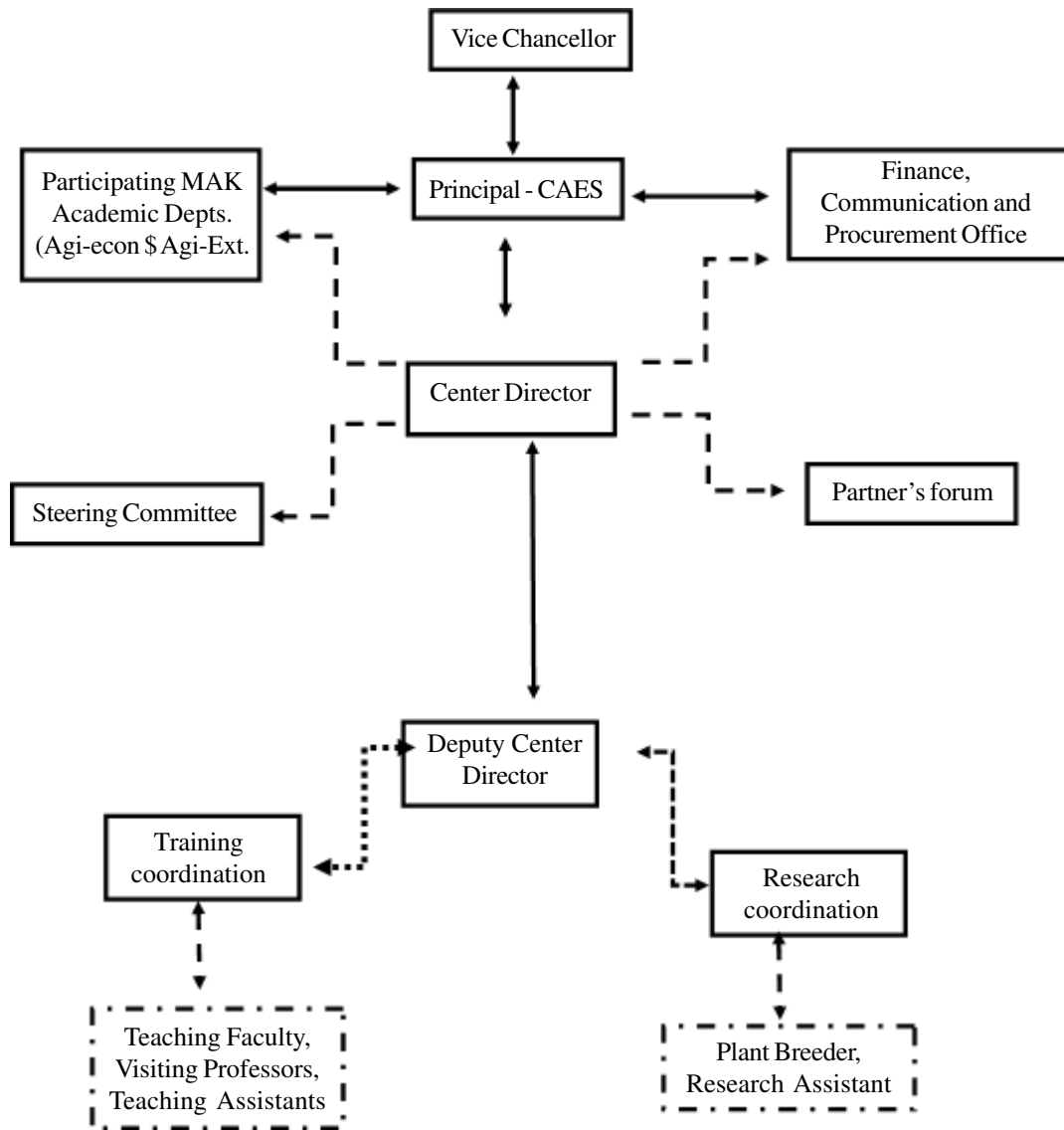
contribute to staff skill enhancements, curriculum improvements and overall strength of the ACE.

**Governance and management of MaRCCI.** The MaRCCI will operate under the 2006 Makerere University Act, the provisions of which allow the hosting College of Agricultural and Environmental Sciences to not only award Degrees, Diplomas and Certificates but also create unique units such as MaRCCI to improve efficiency and increase prominence of specialized activities. The MaRCCI will be created as a semi-autonomous centre. However, the Centre will be regulated by existing Human Resources, Financial and Procurement procedures of the University.

The Center's general management will be administered through the College of Agricultural and Environmental Sciences at Makerere University as a semi-autonomous entity. The Governance and administrative structure is depicted in Figure 1. The designated Center Director (CD) will provide overall oversight to MaRCCI activities and report directly to the Principal of the College Agricultural and Environmental Sciences. The CD will be assisted by a Deputy Center Director and a Project Officer. With the help of the DCD, the Center Director will provide regular technical and financial reporting as prescribed by the ACE II program. The DCD will oversee training and research affairs, and organize regular meetings with all collaborating partners, especially in regard to the students' progress toward their research goals in the various collaborating breeding programs. The CD will be the designated accounting officer for MaRCCI at Makerere University. He/she will be kept abreast of progress through regular meetings with the DCD, personal participation in project meetings, and receipt of project technical and financial reports.

To strengthen operations of the MaRCCI a Senior Plant Breeder - an experienced person knowledgeable in current global trends in training plant breeders will be hired. He/she will act as an overall advisor to the training and research activities of the program. In addition, positions of Postdoctoral Research Scientists have been created to attract bright junior scientists to contribute to the program prior to them being transitioned to formal university employment.

The Center management follows an implementation plan that addresses both Makerere University and ACE II reporting requirements, as well as arrangements agreed upon with cooperating partners. A competent Program Officer (PO) supports the CD in human resource management. The PO is involved but not limited to (i) ensuring the project is in compliance with ACE II procedures (ii) Supporting students/partners with guidance on routine university procedures such as student registration, linkage to faculty internet, library access, etc. (ii) Supporting students/partners in their compliance with immigration issues, obtaining appropriate medical insurance, and banking access, (iii) Arranging for students/partners accommodations and other conveniences (iv) Arranging logistics for visiting lecturers, and (v) Making logistical arrangements for key functions of the Center, e.g., proposal defenses, progress reports, seminars, and other functions.



**Figure 1. Makerere University Regional Center for Crop Improvement organization Chart**

To further strengthen governance and promote quality and international competitiveness of the Centre, an Advisory Committee (AC) composed of representatives from Makerere University, partnering institutions (International and National), partner universities, National Agricultural Research Institutes (NARIs), seed companies, and CGIAR centers will be established. The AC will meet at least twice a year to guide the project planning, implementation, and progress in delivering critical outputs and outcomes.



## **Looking ahead**

MaRCCI is poised to catalyze a continent-wide transformation in plant breeding and seed systems training. However, this will require that it develops a good strategy for sustainable financing to enable implementation and continuation of all activities, thus achieving its educational and research mission. Future operational funding will largely come from tuition flow-back to the program. Development Partners will sponsor some students, but increasing support should come from national governments and seed companies (local and international) and other agencies and indeed individuals. However, this will continue to be a challenge since education continues to compete for funding with other equally pressing issues. MaRCCI will also need to address the issue of inadequate academic staffing to meet the demand for student numbers, the intensity of the program, and mentoring needs. MaRCCI will hire some academic staff on ACE II funding, and with time Makerere University is expected to increase the staff capacity of the centre.

The MaRCCI intends to implement a well-developed and coordinated e-content and blended delivery to keep the program relevant. Blended course delivery may be difficult, but MaRCCI commitment and working with institutions experienced in such delivery should produce success. Students may arrive unprepared. The curriculum revision, patterned after the successful MSc and PhD programs, should address that weakness.

It is also possible that the PhD program may not attract as much funding from donors as the MSc program due to the length of training time (4 years versus 2 years) and implications on cost to train. Raising quality standards to match/exceed the successful MSc program will attract donors.

MaRCCI's research output, in terms of improved varieties, and strengthen capacity for value chain delivery is expected to reach the final beneficiaries – the farmers, rural poor and seed industry. The Center targets to develop varieties responding to smallholder farmer needs and will collaborate closely with seed companies to ensure delivery and adoption.

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**References**

- Alliance for a Green Revolution in Africa (AGRA). 2016. Africa Agriculture Status Report 2016. Progress Towards Agricultural Transformation in Africa. 6 September 2016. 300pp.
- African Development Bank, 2010. [Http://Www.Statistica.Com/Statistics](http://www.Statistica.Com/Statistics)
- DeVries, J. and Toenniessen, G. 2001. Securing the Harvest. Biotechnology and Breeding Methods for African Crops. CABI Publishing, London.
- Food and Agriculture Organisation (FAO). 2006. Food and Agricultural Organisation of the United Nations, Year book of statistics figures. Rome Italy.
- Flaherty, K. and Lwezaura, D. 2010. Long-term investment and capacity patterns in agricultural R & D in Tanzania. Agricultural Science and Technology Indicators - DRD Country Notes.
- Flaherty, K., Kitone, D. and Beintema, N. 2010. Long-term investment and capacity patterns in agricultural R & D in Uganda. Agricultural Science and Technology Indicators – NARO Country Notes.
- Flaherty, K., Kelemework, F. and Kelemu, K. 2010. Long-term investment and capacity patterns in Agricultural R & D in Ethiopia. Agricultural Science and Technology Indicators – EIAR Country Notes.
- Flaherty, K., Murithi, F., Mulinge, W. and Njuguna, E. 2010. Long-term investment and Capacity patterns in Agricultural R & D in Kenya. Agricultural Science and Technology Indicators – KARI Country Notes
- Flaherty, K. and Munyengabe, J.M. 2011. Long-term investment and Capacity patterns in Agricultural R & D in Rwanda. Agricultural Science and Technology Indicators – ISAR Country Notes.
- World Bank and Elsevier. 2015. A Decade of Development in Sub-Saharan African Science, Technology, Engineering and Mathematics Research. Washington, DC: Elsevier.
- World Bank 2016. An Eastern and Southern Africa Higher Education Centers of Excellence Project Report No: Pad1436.