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# FACT SHEET

# PhD Plant Breeding and Biotechnology

## Rationale

Investing in plant breeding is a matter of urgency because of the diverse needs of the Africa's farming community and persistent poverty and food insecurity. Recent surveys by the Forum for Agriculture Research in Africa (FARA) and the New Partnership for Africa's Development (NEPAD) as well National Poverty Reduction Strategy Papers all advocate for increased development and use of science and technology to address the continent's persistent hunger and poverty. Similarly, the Food and Agriculture Organisation (FAO) and others have conducted studies which all point to the very limited capacity in terms of high level trained plant breeders especially in sub-Saharan Africa. This has led to limited variety releases and general weakened innovations systems yet these are critical for enhancing productivity to address food insecurity and livelihood issues.

Africa's human resources suffer from severe attrition due to socio-economic reasons and diseases such as HIV/AIDS. Indeed, rebuilding the continents' human resources may require investment levels similar to what China, South-east Asia and the emerging economies of Brazil and Argentina undertook to strengthen innovations systems for agricultural sector expansion and science-led growth of their economies. Thus the design of the PhD programme took into account experiences from other countries, especially Brazil, where significant science and techno-

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## Programme goal

The goal of this programme is to contribute to the development of human resources and research capacity for crop improvement and related development areas in Sub-Saharan Africa but with particular emphasis on Eastern, Central and Southern African countries.

## Programme objectives

The specific objectives of the programme are:

- To give graduates an opportunity to broaden and deepen their knowledge in Plant Breeding and Biotechnology that will permit them to effectively engage in science-led agricultural development.
- To produce high caliber scientists who will lead training and research, and provide leadership by providing the students with an understanding and hands-on experience of the different disciplines within the realm of plant breeding and biotechnology, research management and broader development issues.
- To strategically invest in the building of a strong national-regional-global consortium to support and develop (where non-existent) PhD training programmes built on shared and rationalized regional resources for a strong agricultural science and innovative base within Eastern, Central and Southern Africa and beyond.

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logical innovation progress has been achieved through the tri-partite linkage amongst universities, research institutions and the private sector. The design also took into account the widespread capacity gap in the region and the fact that isolated cases of expertise exist across the region which could be harnessed to produce a quality graduate programme. Scooping visits were also made to Europe, South Africa and USA to learn about institutional arrangements for delivery of quality PhD programmes, leading to adoption of strong course based PhD training that involves engagement with other leading experts in the training. The design benchmarked the PhD Programme with PhD programmes at Swedish Agricultural University and Stellenbosch University in South Africa. It also established a Regional Academic Advisory Board and partnership with the Uganda National Agricultural Research Organisation and the CGIAR centres operating in the region. Additionally the programme built on lessons from the AGRA supported University of KwaZulu Natal Plant Breeding Programme and identified training of especially university staff at PhD level as its niche (as opposed to the AGRA focus on building capacity for research institutions). To take advantage of the experience and expertise of the KwaZulu Natal PhD programme, the programme has engaged faculty from KwaZulu Natal in teaching delivery.

## Graduate Profile

### Competences within basic sciences

1. The ability to comprehend and evaluate new technologies in relation to existing knowledge.
2. The ability to transfer principles and results from basic and strategic sciences to the development of ideas.
3. The ability to evaluate methods for solving complex development problems.

### Competences within applied science

1. The ability to expand principles from basic science to organise experiments and solve problems.
2. The ability to analyse and comprehend existing knowledge and to transfer knowledge to develop hypotheses and evaluate their usefulness in the context of farming problems.
3. An understanding of aspects of biotechnology related to crop improvement and management.
4. Competence to design experiment and ultimately develop new crop varieties in conjunction with farming communities.

### Competences within ethics and values

1. The ability to formulate ethical problems and clearly communicate possible solutions orally and in writing at the appropriate level for a given audience.
2. An awareness of different attitudes to scientific innovations especially emergent scientific methods such as biotechnology and the ability to discuss and advice policy development for the greater benefit of society.
3. Personal mastery and soft skills to innovate change processes manage, work and guild among communities.

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## Mode of delivery

The PhD in Plant Breeding and Biotechnology is constituted by course work and research leading to writing a thesis and is implemented over three years with a maximum of 4 years covering a total of 8 semesters. Plans are underway to develop online courses and to utilize video conferencing for joint teaching with other universities.

## Coursework

Depending on the theoretical background of candidates, they are required to take courses recommended by the doctoral committee. Coursework consists of;

- Core courses mandatory for all candidates.
- Courses considered relevant and beneficial to the candidate but outside the department as electives.
- Courses available in other institutions to deepen understanding for special research interests and personal competence skills of the student.

## Guidelines for research

The research should address regional constraints identified by Sub-Regional Agricultural Research Organizations (ASARECA, CORAF, CCARDESA), National Programmes and others that exist in the region; should support effective development of human resources for country and regional needs; should also address national constraints not covered by sub-regional organization (SRO) priority areas; the programme should as much as possible cover the "orphan crops" that are not receiving much support through global research efforts; impart new knowledge and advances in science and technology and research for development; develop high quality research products; be linked to national and or regional development trends to strengthen the knowledge base and ability to innovate and be part of the global knowledge-based economy.

## Method (s) of assessment

## Coursework

Students sit coursework examinations on semester basis, and are expected to pass all end-of semester examinations in core courses and respective elective courses, to qualify to proceed to do their research. The university uses External Examiners as part of quality assurance. At the end of the course/ module, each lecturer administers a questionnaire for evaluation.

## Thesis

The research phase is examined by written thesis and oral presentation. A Doctoral Committee examines student's thesis. The Doctoral Committee forms part of the viva voce committee with two to five additional independent members (from firms, industries, retired academicians, and relevant ministry etc.). However, the presentation is OPEN to the public although the final assessment is by the committee members.

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## Course Content and structure

The programme consists of coursework, written examination and thesis. The coursework part of programme is made up of the following courses

### Year 1: Semester I

LH: Lecture Hours; PH: Practical Hours; CH: Credit Hours; CU: Credit Units

| Core Courses | | LH | TH | PH | CH | CU |
|---|---|---|---|---|---|---|
| CRS 9101 | Applied Plant Breeding | 15 | - | 30 | 30 | 2 |
| CRS 9102 | Advanced Molecular Biology and Genetics | 30 | - | 30 | 45 | 3 |
| CRS 9103 | Applied Agricultural Statistics and Research Methods | 30 | - | 30 | 45 | 3 |
| CRS 9104 | Advanced Plant Breeding | 30 | - | 30 | 45 | 3 |
| **Electives** | | | | | | **6** |
| Total Required CU | | | | | | **17** |
| **Electives** | | | | | | |
| CRS 8109 | Agronomy and Crop Physiology | 15 | - | 30 | 30 | 2 |
| CRS 9106 | Molecular Plant Microbe Interactions | 30 | - | 30 | 45 | 3 |
| CRS 9107 | Sustainable Seed Systems | 30 | - | 30 | 45 | 3 |
| CRS 9206 | Personal Development and Social Skills | 15 | - | 30 | 30 | 2 |
| | | | | | | |
| **Year I: Semester II** | | | | | | |
| **Core courses** | | | | | | |
| ABM 7201 | Agricultural and Food marketing | - | - | 60 | 30 | 3 |
| ABM 8202 | Programme Planning and Management | 15 | 30 | - | 30 | 2 |
| CRS 9202 | Applied Molecular Biology and *In vitro* Techniques | 15 | - | 30 | 30 | 2 |
| **Electives** | | | | | | **6** |
| Total required CU | | | | | | **13** |
| **Electives** | | | | | | |
| CRS 9203 | Bioinformatics and Functional Genomics | 30 | - | 30 | 30 | 2 |
| CRS 9204 | Advanced Insect Pest Management Systems | 15 | - | 30 | 30 | 2 |
| CRS 9205 | Disease Management and Crop Loss Assessment | 15 | - | 30 | 30 | 2 |
| CRS 8201 | Quantitative and Biometrical Genetics | 30 | - | 30 | 30 | 2 |
| SOS 9201 | Soil-Plant-Atmosphere relations | 15 | - | 30 | 30 | 2 |

## Implementation progress and achievements

The programme was launched in 2008. The subsequent cohorts of students reported in 2011 and 2013.

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The fourth cohort is due to report in August 2014

## Outputs from the Programme so far

Publications and manuscripts:

Journal papers: 50

Conference proceedings: 60

## Student numbers

Table 1 below gives a summary of student's statistics, since launch of the programme.

**Table 1: Student numbers in the Plant Breeding and Biotechnology Programme (2008 - 2015)**

| Year of Intake | Student Numbers (% females in brackets) | Status of Students | Countries of origin of the students |
|---|---|---|---|
| Cohort 1 (2008) | 22 (23%) | 16 graduates have submitted theses; 7 awaiting the viva voce | Kenya, Malawi, Uganda, Zambia, Zimbabwe |
| Cohort 2 (2010) | 6 (50%) | Finalizing thesis write-ups | Sudan, Zambia, Kenya, Uganda |
| Cohort 3 (2012) | 5 (25%) | In a process of writing thesis and development journal publications | Benin, Ghana, Nigeria, Sudan, Uganda |
| Cohort 4 ( 2013) | 12 (75%) | Conducting research | Zambia, Ethiopia, Uganda, |
| Cohort 5 ( 2014) | 8 (25%) | Concluding coursework for the first year | Ethiopia, Benin, Uganda, Malawi, Ghana |
| Cohort 6 ( 2015) | 9 (33%) | Just reported for classes | Sudan, Tanzania, Uganda, Ghana, Malawi |

## Staff exchanges / visiting lecturers

| | National | Regional | International |
|---|---|---|---|
| Cohort 1 | 6 | 6 | 4 |
| Cohort 2 (on-going) | 4 | 2 | 1 |
| Cohort 3 (on-going) | 8 | 4 | 3 |

## Positive Outcomes

The programme attracted funding from the Uganda Millennium Science Development initiative and RUFORUM to sponsor 22 PhD students from Eastern and Southern Africa with full scholarships ($.60,000 per scholarship). The programme has recently been earmarked by the Uganda Ministry of Agriculture, Animal Industry and Fisheries to train 12 PhD students under Uganda Government funding. In addition, the programme has attracted funding from the ACP-EU Intra Academic Mobility Pro-

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gramme to train 5 PhD students from Ghana, Benin, Burundi, Nigeria and Ethiopia. Other funding support to train 5 PhD students (from Ghana, Nigeria and Sudan) had been secured from Carnegie Corporation of New York and DAAD. This year (2014) ACP-EU Intra Academic Mobility program will fund 8 PhD students from Benin, DR Congo, Ethiopia, Ghana, Mali, Mozambique, South Sudan, and Senegal to train under the programme. Additionally,

1. The East African Community has identified the programme as its regional centre for training plant breeders in the region. Discussion on financial implications is ongoing.
2. Because of the good feedback on the programme the Uganda government has decided to train 54 Masters and PhD students through RUFORUM regional programmes. Students have already been sent to the University of Nairobi Dryland programme, Egerton University and Lilongwe University of Agriculture and Natural Resources.
3. The profile and visibility of Makerere University has been enhanced at international level. This has contributed to the institution's improved ranking from position 68 to its current position of 4$^{th}$ top Universities in Africa, being the most highly ranked university outside South African universities.
4. The Programme has strengthened staff capacities of RUFORUM member universities and National Agricultural Research Institutes in the ECSA region. For example, students trained under the PhD programme have returned to their home countries to lead plant breeding programmes and other leadership positions:
   a) Mcebisi Maphosa from Zimbabwe is heading a department at Lupane State University and has already established a Plant Breeding programme.
   b) Edmond Gasura has been appointed a lecturer at University of Zimbabwe and has initiated a plant breeding programme
   c) Abel Sefasi has been appointed a lecturer at the newly established Lilongwe University of Agriculture and Natural Resources and has been charged with establishing a Biotechnology Unit
   d) Langa Tembo is back at University of Zambia as a Lecturer and is helping to build the plant breeding programme and establish a biotechnology programme. He has also been appointed the RUFORUM focal contact person for University of Zambia.
   e) James Mwololo from Kenya has been appointed lecturer at Pwani University, Kenya.
5. By hosting and implementing the programme, the networking and collaboration profile of Makerere and other member universities of RUFORUM have been enhanced, with new opportunities for partnerships for resource

mobilization, enhancing quality of both undergraduate and other postgraduate programmes. As a result the experience in marshalling partnership has contributed significantly to Makerere being considered one of the most competitive university in grant sourcing under the European-Africa-Caribbean-Pacific competitive grant system. See also journalist story on Makerere University at www.ruforum.org