



WACCI

**West Africa Centre for Crop  
Improvement**

**New Four Year PhD Programme In Plant Breeding for  
West Africa Centre For Crop Improvement**



**University of Ghana**

## **Introduction**

The West Africa Centre for Crop Improvement (WACCI), a partnership between the University of Ghana (UG) and Cornell University, was established with funding from the Alliance for a Green Revolution in Africa (AGRA) in June 2007 to train Plant Breeders for the West and Central Africa sub region. Five cohorts comprising 44 PhD students from 7 countries (Burkina Faso, Cameroon, Ghana, Mali, Kenya, Niger and Nigeria) are currently enrolled at WACCI for the first phase of its programme. WACCI is currently soliciting funds for its second phase, to enroll two additional cohorts of students to undertake a four year degree programme.

## **Admission Requirements**

The WACCI programme is specifically for full-time, professional plant breeders who will make their careers breeding new cultivars of food crops. Prospective students should be under the age of 40 and must have a Masters degree in a relevant discipline. They must have a position as an agricultural research scientist in a national research institute or university, so that the student can return to their home country to conduct the field research for the PhD thesis.

## **Duration of Study Programme**

The duration for completion of the Doctor of Philosophy degree shall be 4 years. Students will be expected to take a year of taught courses before proceeding to their home country for at least two and a half years (2 ½ years) to conduct their research.

## **Graduation Requirements**

To graduate, students must pass all core courses and a comprehensive examination at the end of the first year. In all cases, the University of Ghana Regulations in the Handbook for Graduate Studies shall apply. Students must obtain a total of 75-81 credits as prescribed below.

Year 1:	First semester courses	9-12 credits
	Second semester courses	9-12 credits
	Seminar 1	3 credits
Year 2:	Seminar 2	3 credits
	PhD Research	-
Year 3:	Seminar 3	3 credits
	PhD Research	-
Year 4:	Seminar 4	3 credits
	PhD Research and Writing of Thesis	45 credits
<b>Total Credits</b>		<b>75-81 credits</b>

## **Degree to be awarded**

The following degree will be awarded upon successful completion of the graduation requirements: Doctor of Philosophy degree (PhD) in Plant Breeding.

## Programme Structure

YR/SEM	COURSES	CREDITS
<b>YEAR 1</b> <i>Semester 1</i>	<b>Core courses</b> WACI 701: Biometry and Experimental Design WACI 703: Biotechnology in Plant Breeding WACI 705: Plant Genetics <b><u>Elective courses</u><sup>1</sup></b> WACI 707: Host Plant and Pathogen Interactions WACI 709: Plant Pests and Integrated Pest Management	3 credits 3 credits 3 credits 3 credits 3 credits
<i>Semester 2</i>	<b>Core courses</b> WACI 702: Quantitative Inheritance in Plant Breeding WACI 704: Physiology of Environmental (abiotic) Stresses WACI 706: Genetic Improvement of Crop Plants WACI 710: PhD Seminar 1 <b><u>Elective courses</u><sup>1</sup></b> WACI 708: Plant Cell Tissue Culture WACI 712: Plant Virology <b>Total</b>	3 credits 3 credits 3 credits 3 credits 3 credits 3 credits <b>24 Credits</b>
<b>YEAR 2</b>	WACI 720: PhD Seminar 2 WACI 700: PhD Research	3 credits (-)
<b>YEAR 3</b>	WACI 730: PhD Seminar 3 WACI 700: PhD Research	3 credits (-)
<b>YEAR 4</b>	WACI 740: PhD Seminar 4 WACI 700: PhD Research & Writing of Thesis <b>Total Credits</b>	3 credits 45 credits <b>75-81</b>

### Description of Courses WACI 701: Biometry and Experimental Design

This course is designed to equip students with knowledge and skills in the application of statistical methods to analyse data arising from a wide range of applications. Topics include:

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<sup>1</sup>Students have a choice of two of the four electives in the first year, WACI 707 or WACI 709 in the first semester and WACI 708 or WACI 712 in the second semester. In consultation with members of the supervisory committee, students may take elective courses offered at the undergraduate and post graduate levels (300, 400 or 600). Students shall not take more than 3 credits from the undergraduate level and not more than 6 credits from the post graduate level (600).

parametric statistical methods used in agricultural research; hypothesis testing; principles of experimental designs; analysis of simple and complex experiments; covariance analysis and alternatives; simple and multiple correlations and regression; non-parametric methods; scientific writing and research report preparation; research planning and design; field research including on-station, on-farm, multi-location, multi-season and long-term experiments; survey research questionnaire construction and sample selection; methods and importance of error control in research; controlled-environment studies; breeding designs and mating systems and genetics data handling.

### **WACI 702: Quantitative Inheritance in Plant Breeding**

This course is designed to provide students with in-depth knowledge of quantitative genetic theory to enable them evaluate relevant literature in the discipline and also be equipped to design, execute, analyse and interpret results of experiments involving polygenically controlled characters in plant breeding programmes. The topics covered include: genetic structure of plant populations, genetic values and means, covariance among relatives and heritability estimates. Response to natural and artificial selection, multi-trait selection and correlated response to selection. Mating designs and consequences on population structure. Genotype x environment interaction. Quantitative trait loci analysis.

### **WACI 703: Biotechnology in Plant Breeding - 3 credits**

Plant biotechnology, genome research and plant breeding now underpin all aspects of agriculture world-wide. The objective of this course is to provide students with the theory and practical skills of plant genetic manipulation relevant to plant biotechnology, plant breeding and genome research. Topics to be covered include: Tissue and cell culture and their applications in crop improvement, DNA markers and applications in crop improvement and Genetically modified organisms (GMOs) in plant breeding.

### **WACI 704: Physiology of Environmental (abiotic) Stresses - 3 credits**

This course examines the responses of plants to environmental stresses. Topics include plant growth and development; the influence of the environment; evolution and adaptation; comparative ecology and phenology; the acquisition of resources: energy and carbon, mineral nutrients, water, temperature, toxicity; ecological perspectives, the individual plant, interactions among plants, interactions between plants and other organisms; strategies and dynamics.

### **WACI 705: Plant Genetics - 3 credits**

**This course is aimed at enhancing students understanding of the processes and mechanisms of transmission genetics; Mendelian genetics and extensions of Mendelian genetics; dominance relations and multiple alleles; gene interactions; linkage and linkage maps; cytogenetics, extrachromosomal inheritance; plastids and mitochondria; nucleic acids structure; DNA, replication and function; protein structure and function; mechanisms of genetic change; gene mutation; recombination; transposable genetic elements; functional, structural and comparative genomics and gene finding and annotation.**

### **WACI 706: Genetic Improvement of Crop Plants - 3 credits**

This course is designed to equip students with knowledge of concepts and principles of plant breeding. Topics include crop evolution, geographical distribution and conservation of crop genetic resources, reproduction of crop plants and fertility regulating mechanisms, breeding and selection methods for self and cross pollinated crops, heterosis, inbreeding depression and hybrid development, population improvement methodologies, breeding for resistance to disease and pests, breeding for abiotic stress resistance, applications of molecular technologies to crop improvement including marker assisted selection, breeding for end user traits, breeding for nutrient enhancement.

### **WACI 707: Host Plant and Pathogen Interactions - 3 credits**

The course will introduce students to recognize plant diseases; the biology of plant pathogens and the cause of disease; mechanisms of disease development and factors influencing disease development; host-pathogen interaction; the mechanism of host defense; the nature and expression/resistance; the development of appropriate screening techniques for identification and assessment of resistance; plant disease management; virus structure, characterization and mechanisms of transmission; and virus movement and development of infection.

### **WACI 708: Plant Cell Tissue Culture**

The course discusses the principles, protocols and utilization of plant cell tissue culture systems. Topics would include embryogenesis, organogenesis and plant regeneration; isolation, culture genetic manipulation of plant protoplast; somatic hybridization; selection of somatic hybrid plants; transformation of plants; protoplast culture and fusion; selection of plant cells for desirable characteristics; haploid cell cultures; embryo rescue and uses; secondary metabolites production by cell suspension culture; cryopreservation and storage of germplasm; tissue culture methods in phytopathology and commercial micro propagation.

### **WACI 709: Plant Pests and Integrated Pest Management – 3 credits**

This course is intended to give students a broad overview of plant pests associated with field crops in West and Central Africa. Students will gain a comprehensive understanding of the concepts in integrated pest management and its application as a pest control strategy. They will also be trained in the design and implementation of IPM programs.

### **WACI 712: Plant Virology**

This course will enable students to appreciate the interaction between viruses and their host plants. Topics to be covered include: the mechanism and evolution of plant viruses, virus purification and characterization, virus classification, structural organisation of RNA Viruses, structural organisation of DNA viruses, expression and analysis of viral genes, replication of viruses, movement of plant viruses, transmission of viruses and important viral diseases of crop in West Africa.

### **Seminar Topics**

An essential part of the training at WACCI is the opportunity to hear the research accomplishment of leading scientists working at the forefront of plant genetics, breeding and

biotechnology research. Seminars provide an ideal means of exposing PhD students to new ideas and research methodology being developed at leading research institutions. Students have a wide variety of seminars in the underlying sciences to provide this enrichment. Experts will be invited to speak and instruct on practical experiences in the following subject areas - Seed Business Development; Scientific Communication and library tools; Participatory Research Appraisal (PRA); Geographic Information Systems (GIS) training; Leadership Training; Modern Plant Breeding Methods including genotyping-by-sequencing and associated phenotyping to facilitate marker assisted breeding. Students also present four seminars during the period of their PhD training.

## **Description of Student Seminars**

### **WACI 710: Seminar 1**

The PhD at WACCI involves a three-year period of research in the students' home institution after the first year of course work. Students are required to present a seminar on their PhD research proposal. This will cover the background for the research, the problem to be investigated, the objectives and the methodologies to be used including data analysis, a plan of the work to be carried out and the expected outputs. Students will be expected to give a seminar to be followed by a general discussion. It is expected that all members of the supervisory committees will be present at the proposal seminars.

### **WACI 720: Seminar 2**

Students at WACCI conduct a Participatory Rural Appraisal (PRA) as part of their research. This allows them to understand the problems encountered by farmers as well determine the preferences of farmers as regards varietal needs. In the second year, students will present a seminar on their findings. This will be done during field visits of members of their supervisory committees. Students will present a seminar on the results of their PRA.

### **WACI 730: Seminar 3**

In year three, students will be required to give a seminar on the progress of their research which will be assessed by the team of supervisors. The seminar should highlight experiments conducted within the period, results obtained and statistical methods to be used in analyzing the results.

### **WACI 740: Seminar 4**

Students will give a seminar on the findings of the PhD research in the fourth year prior to submission of their thesis. The Seminar will give details on the research work undertaken and results obtained including discussions and implications of results. Students will be expected to present opportunities for future extension of the work.