

**TUESDAY January 14, 2020**

**COLLEGE OF AGRICULTURAL AND ENVIRONMENTAL SCIENCES**

The Principal College of Agricultural and Environmental Sciences to present the following for the conferment of the

**Degree of Doctor of Philosophy**

PARIYO Anthony (RIP)

**Resolution of genetic structure for resistance to cassava brown streak disease: germplasm diversity, resistance stability and inheritance patterns.**

Mr. PARIYO Anthony (RIP) studied the genetic structure for resistance to cassava brown streak disease (CBSD), an acute disease that has for decades limited optimal cassava productivity in eastern and southern Africa, which is incited by cassava brown streak viruses (CBSVs). Lack of information on genetic diversity, stability and the mode of inheritance of resistance to CBSD severely limits efforts tailored towards its control. The study resulted into three principal conclusions to guide future work: 1) low frequency of CBSD resistance alleles in eastern Africa cassava germplasm; 2) different CBSD resistance gene actions for foliar and root plant parts; 3) significant environments effects, with Namulonge located in central region, being the most suitable location for CBSD resistance screening. This study was funded by the world Bank coded Millennium Science Initiative, through Government of Uganda, and was supervised by Prof. Phinehas Tukamuhabwa and Dr. Yona Baguma.

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**ACHORA Janet Cox**

**Use of Information and Communication Technologies in conservation agriculture knowledge pathways among smallholder farmers in Machakos and Laikipia counties, Kenya**

Ms. ACHORA Janet Cox examined the use of Information Communication Technologies (ICTs) in conservation agriculture knowledge pathways among smallholder farmers in Machakos and Laikipia counties, Kenya. To suggest ways in which emerging ICTs can be integrated for enhanced conservation agriculture knowledge sharing, the study identified that the fragmented conservation agriculture knowledge network, the minor role of ICT actors in conservation agriculture knowledge sharing, the low integration of ICT tools and ICT capacities of conservation agriculture actors, constrained the optimal use of ICTs in conservation agriculture knowledge sharing. The study established that an integrated ICT knowledge sharing framework could improve and integrate the use of emerging ICTs for conservation agriculture knowledge sharing. This study was self-funded and partly supported by the Regional Universities Forum for Capacity Building in Agriculture (RUFORUM), and was supervised by Dr. Haroon Sseguya and Dr. Florence Birungi Kyazze.

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**BUKUSUBA John**

**Modelling the impact of stunting on childhood survival in Buhweju District and the cost of its prevention**

Mr. BUKUSUBA John studied the risk factors for the high rate of stunting in Buhweju District, and modelled the impact of its reduction on child survival and the cost of interventions required. The study found half of the children under 5 years were stunted and boys were more stunted than girls. Stunting was largely attributed to low coverage of child survival interventions, morbidity, low consumption of animal-source foods, food insecurity, poverty, and lack of knowledge about stunting. The cost for the reduction of stunting was estimated at US\$ 21.2 million for the period 2018-2030, necessitating an additional US\$ 250,000 per year for scale up. The interventions and costed strategy can be adapted for the 5-year district development plan and the development of a new multi-sectoral nutrition policy and national development plan. This study was funded by Nestlé Foundation, and was supervised by Prof. Archileo N. Kaaya and Dr. Abel Atukwase.

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**BYAKIKA Stellah (Ms)**

**Studies on the safety of *Obushera* and probiotic potential of selected lactic acid bacteria**

Ms. BYAKIKA Stellah examined the safety of *Obushera*, a popular fermented cereal-based beverage from Uganda. This was motivated by the increasing uncontrolled commercial production of *Obushera* which compromises consumer safety. She also evaluated the potential contribution of three lactic acid bacteria isolated from *Obushera* towards improving product safety and human health. Findings showed presence of virulent, antibiotic-resistant and acid-tolerant *Escherichia coli* and aflatoxins in some *Obushera* sold in Kampala. The isolates; *Lactobacillus plantarum* MNC 21, *Lactococcus lactis* MNC 24 and *Weisella confusa* MNC 20 bound aflatoxins, inhibited *Escherichia coli* and exhibited the potential to reduce blood cholesterol, stimulate insulin release and stabilize heart pressure. Adoption of the isolates in processing of *Obushera* and related products could improve safety and health. The study was co-funded by Mr. Samuel K. Byakika and the Food Technology and Business Incubation Center, and was supervised by Assoc. Prof. Ivan Muzira Mukisa and Prof. Charles Muyanja.

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**GEBREMEDHN Hailay Mehari**

**Genetic Resistance to Soybean Rust (*Phakopsora pachyrhizi*) in Line UG-5**

Mr. GEBREMEDHN Hailay Mehari studied the genetic resistance to soybean rust in line UG-5. Soybean rust (SBR) is a devastating foliar diseases causing high yield losses worldwide. In Uganda, a local line UG-5 seems to have unique genes showing potential contribution towards improvement of SBR, but genetic control of its resistance is not yet characterized. The study

revealed significant GCA effects and high Baker's ratio, suggesting the predominance of additive gene action in the inheritance of SBR resistance. Three putative QTLs were identified on chromosomes 6, 9 and 18. The QTL detected on chromosome 9 was novel and has not been reported elsewhere. Plant defense signaling pathway-related candidate genes were predicted from the QTLs on chromosomes 9 and 18, which could facilitate efficient MAS and gene pyramiding for the development of durable resistance to SBR. This study was funded by INTRA-ACP Mobility Scheme, and was supervised by Prof. Phinehas Tukamuhabwa and Dr. Tomas L. Odong.

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**KIRYOWA Moses**

**Resistance spectrum to anthracnose disease and the genetic effect of pyramided genes on yield in common bean**

Mr. KIRYOWA Moses determined the pathogenic variability of *Colletotrichum lindemuthianum* (fungus causing anthracnose disease); assessed the effectiveness of pyramided resistance genes against anthracnose disease; and determined genetic effect of pyramided genes on yield in beans. *C. lindemuthianum* was highly variable with 24 new physiological races, worthy of attention. Pyramided genes in the right combination conferred broad-spectrum resistance but with a yield penalty. Some single genes conferred broad-spectrum resistance but may not be durable. The decision to pyramid resistance genes should, therefore be weighed against the threat the pathogen poses. The effective single and pyramided genes are a resource for breeders and pathologists. This study was funded by the National Agricultural Research Organization (NARO) and the International Centre for Tropical Agriculture (CIAT) -Uganda and was supervised by Prof. Phinehas Tukamuhabwa and Dr. Stanley Nkalubo.

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## **KUMI Frank**

### **Studies of sorghum resistance to downy mildew (*Peronosclerospora sorghi*) disease in Uganda**

Mr. KUMI Frank studied the prevalence, distribution and population structure of downy mildew disease in major sorghum growing districts in Uganda. He also characterized *Peronosclerospora sorghi* isolates which causes downy mildew disease. His study found Arua, Namutumba and Pallisa as downy mildew disease hotspots. In addition, temperature, relative humidity and rainfall were the main drivers for downy mildew epidemics. He further screened Uganda sorghum germplasm for sources of resistance to downy mildew disease under different disease pressure. Two parents and seven crosses were identified as good transmitters of resistance to downy mildew disease and are recommended as lines in a sorghum breeding programme targeting downy mildew resistance and yield improvement. This study was funded by Intra-ACP CSAA project and RUFORUM, and supervised by Prof. Patrick Rubaihayo and Dr. Moses Biruma.

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### **MIESHO Belay**

#### **Genetics of cowpea resistance to bruchid (*Callosobruchus maculatus* Fab.)**

Mr. MIESHO Belay studied Bruchids (*Callosobruchus maculatus*), which is one of the most destructive insect-pests of cowpea causing significant losses in storage. The study was designed to contribute to the reduction of cowpea storage losses through elucidation of cowpea genetics of resistance to bruchids. Through intensive phenotyping, seed biochemical and inheritance studies, four cowpea genotypes (2419, WC42, TVu-2027 and IT84s-2246) resistant to bruchids were identified and recommended as donor parents for cowpea breeding against bruchids. Furthermore, eleven genomic regions and six candidate genes associated with the resistance traits were identified using genome-wide association study which could be used for marker assisted breeding. This study was funded by DAAD and Carnegie through RUFORUM; and University of California through MaRCCI; and was supervised by Prof. Patrick Rubaihayo and Prof. Samuel Kyamanyawa.

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### **MSISKA Mercy Ulemu**

#### **Genetic resistance to adzuki bean bruchid in soybean**

Ms. MSISKA Mercy Ulemu studied the genetic resistance to adzuki bean bruchid (*Callosobruchus chinensis*) in soybean. Utilization of resistant varieties to manage bruchids is

obstructed by lack of sources of resistance and information on genetics of inheritance. Msiska's study established sources, basis and inheritance of resistance to *C. chinensis* in soybean. Two genotypes; AVRDC G8527 and PI G89 were identified as sources of resistance. High tannins, total antioxidants, peroxidase activity and low flavonoids were biochemicals associated with resistance. Potential parents in breeding for resistance were SREB-15C, S-Line 9.2 and S-Line 13.2A. Crosses of the SREB-15C x S-Line 13.2A and SREB-15C x Maksoy 3N were recommended as start up material for the breeding programme. This study was funded by Intra ACP-CSAA, APPSA and Carnegie Corporation of New York through RUFORUM, and was supervised by Prof. Phinehas Tukamuhabwa and Prof. Samuel Kyamanywa.

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**NATABIRWA Hedwig (Ms)**

**Common bean (*Phaseolus vulgaris*, L.) extrusion cooking: process optimization and product evaluation**

Ms. NATABIRWA Hedwig researched on extrusion of biofortified common beans, with focus on improving the nutritional quality of expanded starchy snack foods, commonly consumed by children. Her work showed that extruded bean product properties were associated with the bean chemical components, and influenced by the extrusion cooking conditions used. She optimized extrusion conditions, thus producing a bean snack with high protein and iron content, and improved protein digestibility. Her research proved that biofortified common beans can be used to produce highly acceptable and nutritive puffed snacks, thus promoting increased intake of macro- and micro-nutrients. The developed process provides an alternative and economically feasible extrusion processing methodology that can be used by industry for production of nutritious expanded snack products. The study was funded by the ADB-GOU HEST research corporation through CIAT and supervised by Prof. John H Muyonga and Assoc. Prof. Dorothy Nakimbugwe.

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**NDIRIGUE Jean**

### **Adaptation and genetic analysis of earliness and yield component traits of yam bean (*Pachyrhizus Spp.*) in Rwanda**

Mr. NDIRIGWE Jean studied the adaptation and genetic analysis of earliness and yield component traits of yam bean (*Pachyrhizus Spp.*) in Rwanda. Yam bean, a high yielding and rich root crop in Latin America and Asia was recently introduced into Rwanda for integration into the diverse farming agro-ecologies and improvement of diets of root crop dependent communities. Ndirigwe's study identified high genetic variability, heritability and significant high general ability, specific ability and their variance components indicating that both additive and non-additive genes control earliness traits and expected genetic gain could be expected in genetic improvement of yam beans introduced. High yielding and well adapted genotypes were AC 209033, AC 209035 and EC209018 and were recommended for participatory farmer's selection. This study was funded by the Belgium Technical Cooperation, and was supervised by Prof. Phinehas Tukamuhabwa and Prof. Emeritus Patrick Rubaihayo.

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### **ONYILO Francis**

### **Functional genetics in ascomycetes *Pseudocercospora fijiensis* (Synonym *Mycosphaerella fijiensis*) the pathogen of black sigatoka disease in banana.**

Mr. ONYILO Francis studied Functional Genetics in ascomycetes *Pseudocercospora fijiensis* (formerly *Mycosphaerella fijiensis*) the pathogen of black Sigatoka in Banana. Francis isolated and characterised Mitogen activated protein kinase encoding genes; *PfHog1*, *PfSlt2* and *PfFus3* which are responsible for growth and virulence of *Pseudocercospora fijiensis*. He developed an RNA interference mediated gene silencing mechanism and an *Agrobacterium tumefaciens* mediated transformation procedure to introduce genes into mycelium fragments of *Pseudocercospora fijiensis*. His research is a step towards developing banana cultivars with resistance to black Sigatoka disease. This will help increase overall banana production. Functional genetic tools developed by Francis can be used to investigate other fungal pathogens example *Magnaporthe oryzae* of Rice. This Study was funded by Norman Borlaug Leadership Enhancement in Agricultural Programme University of California Davis USA and Agricultural Biotechnology Support programme II - USAID. His research was conducted under the

mentorship of Prof. Bryce Falk and Prof. Ioannis Stergiopoulos. He was supervised by Dr. Tusiime Geoffrey and Dr. Leena Tripathi.

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**OPOLOT Henry Nakelet**

**Unraveling critical factors for a responsive university-farming community engagement in Uganda: insights from two outreach projects at the School of Agricultural Sciences, Makerere University**

Mr. OPOLOT Henry Nakelet explored factors for development of a systematic long-term engagement framework between universities and farming communities. Findings showed that: the quality of teaching using participatory methods for development of lifelong skills; field attachment duration and appropriateness of host organizations to support practical learning; timely sharing of information; and farmers' capacity development are critical for enhancing the role of universities on agricultural development. The study recommended strengthening application of participatory teaching methods for students to develop lifelong learning skills, increasing field attachment duration in accredited organizations for enhanced practical learning, integration of ICTs for timely information sharing, and mainstreaming farmer training into outreach activities. The study also suggested introduction of a post-graduation apprenticeship as an avenue for professional skills development and long-term engagement. This study was funded by RUFORUM CARP03 Project, and was supervised by Dr. Prossy Isubikalu & Dr. Bernard Obaa.

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**ORIANGI George**

**Urban resilience to climate extremes in Mbale municipality in Eastern Uganda**

Mr. Oriangi George investigated historic and projected occurrence of precipitation extremes up to the year 2050, assessed factors perceived to be influential in enhancing resilience and proposed and tested a Municipality Resilience Index (MRI) to measure household resilience to precipitation extremes in Mbale municipality. Findings revealed that extreme precipitation periods have become and are likely to become more frequent between September and January. Additionally, household ability to meet its daily expenditure needs, household size, networks with NGOs, health care, education, access to credit and employment showed to be crucial factors in enhancing resilience to precipitation extremes. The MRI revealed that Mbale municipality has a low resilience index (0.2). Thus, contributing to previous studies on community resilience and bear relevance for practitioners to understand where to invest more resources to enhance resilience. This study was funded by SIDA and was supervised by Assoc. Prof. Yazidhi Bamutaze, Dr. Paul Isolo Mukwaya and Prof. Petter Pilesjö.

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**WASUKIRA Arthur**

**Comparative analysis of genotypic diversity among *Xanthomonas campestris* pv. *musacearum* and *Xanthomonas vasicola* pv. *vasculorum* strains**

Mr. WASUKIRA Arthur conducted genome wide association studies on bacterial wilt isolates from banana, ensete and sugarcane from Eastern Africa. Bacterial wilt continues to reduce banana productivity and therefore affect livelihoods. He determined two major clades of bacterial strains within Eastern Africa, sequenced fourteen *Xanthomonas* strains and identified thirty-two specific candidate genes. The genome assemblies are useful in molecular dating studies, specific genetic markers used in functional, epidemiological and biogeographical research. New breeding technologies use pathogen-derived effectors as molecular probes to

identify resistance genes for genetic plant protection. This study contributes to transgenic development of banana bacterial wilt resistance through gene editing. The study was funded by Millennium Science Initiative/NARO, University of Exeter, and was supervised by Dr. Geoffrey Tusiime and Dr. Jerome Kubiriba.