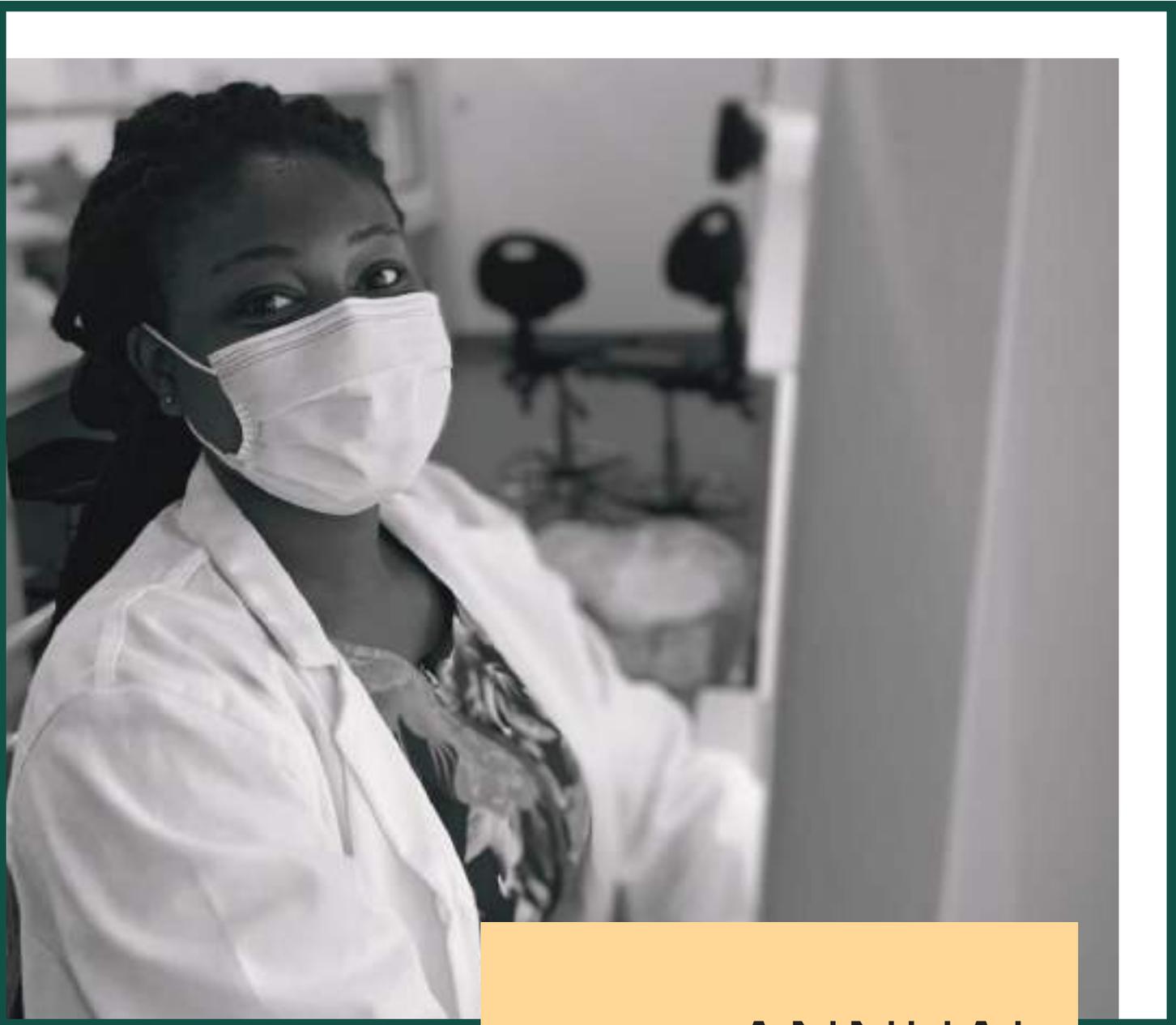


West Africa Centre for Crop Improvement

Africa Centre of Excellence for Agricultural Innovation and Entrepreneurship



ANNUAL **REPORT** 2020

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WEST AFRICA CENTRE FOR
CROP IMPROVEMENT



UNIVERSITY
OF GHANA



ANNUAL REPORT

2020

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01 Director's Message



Eric Yirenkyi Danquah, PhD (Cantab)
Professor and Director

After 12 years of pre-eminence in the plant breeding education space and a frontrunner in the Africa Centres of Excellence project (ACE), WACCI was selected as one of the winners of the ACE Impact grant. We proposed to transform WACCI into an Agricultural Innovation and Entrepreneurship Institution. Driven by our core values of Excellence, Integrity, Commitment to People, Culture of Mentoring, Accountability and Shared Governance, the Centre has put together an excellent multidisciplinary team comprising plant and social scientists and seasoned administrators to train the next generation of game-changers and history makers for the transformation of agriculture in Africa as well as address the critical challenges along the value chains of the important staple crops to increase their productivity and accessibility.

As the Director of WACCI, I feel privileged to be leading the talented project team driving change at this time in the Centre's

transformation agenda. The "Africa We Want" by 2063 cannot be realized if we do not seize the moment to innovate and deliver products so urgently needed in organisations, farmers' fields and markets to accelerate the transformation process.

I invite readers to see our work so far and explore opportunities for partnerships so urgently needed to achieve the Sustainable Development Goal 2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture by 2030. The Covid-19 pandemic teaches us important lessons. Nations cannot rely on other nations for their sustenance. We need self-reliant food systems locally. A business-as-usual approach will worsen the already troubling food and nutrition situation in Africa. Join us to drive a transformational agenda for Africa's agriculture.

02 WACCI at a Glance



The West Africa Centre for Crop Improvement (WACCI), a World Bank Africa Centre of Excellence, was established in 2007 through a partnership between the University of Ghana (UG) and Cornell University with funding from the Alliance for a Green Revolution in Africa (AGRA). The aim of this partnership was to champion the training of Plant Breeders at the PhD level for five countries in the West African sub-region.

Following the successful implementation of the project's first phase, the centre expanded its focus to other countries in Africa. In 2015, WACCI also introduced an innovative MPhil programme in Seed Science and Technology to address the challenges facing the ailing seed sector in Africa.

Currently, the Centre has enrolled a total of 137 PhD and 55 MPhil students from 19 African countries and has graduated 95 PhDs and 15 MPhils. These graduates have gone on to become game-changers and history makers in over 12 countries in Africa. WACCI, over the years, has transitioned from a single donor to a multi-donor funded institution with nearly US\$ 40 million of committed funds.

Enrolment

Total enrolment of **137 PhD (2008 - 2020)** and **55 MPhil (2015 - 2020)** students

High Completion Rate

95 PhD and 30 MPhil graduates (**94.45%** completion rate)

Funding

More than tripled initial investment to nearly **US\$ 40 million**

Strategic Collaborations

Over **40** public and private partnerships including world class educational institutions globally

Breeding programmes

Various breeding programmes established for the improvement of **maize, cowpea, tomato, cassava, frafra potato, sorghum** and **soybean**

Scholarships

Most students have benefited from scholarships through the Center's initiatives

Publications

Over **164** publications by graduates, students and faculty in peer-reviewed journals.

Endorsements

WACCI endorsed as a model for Plant Breeding education in South-East Asia and sub-Saharan Africa by the Chicago Council on Global Affairs

Diversity

Diversity across country, gender, faculty expertise, target crops, funding and partners

Varieties Released

Over 60 varieties released by the Centre's graduates in addition to **3 high yielding (9 to 11 t/ha)** and climate resilient maize varieties released by the Centre.

Infrastructure

Multipurpose building with bioinformatics lab, seed science and tissue culture labs, cold room, lecture theatres, meeting rooms and offices

Sustainability

Endowment fund established with a **US\$ 50 million** target.

Africa Centre of Excellence for Agricultural Innovation and Entrepreneurship



In 2015, the World Bank, in collaboration with countries in Western and Central Africa launched the Africa Centres of Excellence (ACE) project. Following a competitive and merit-based assessment WACCI was selected as one of the first ACE Centres. The project over the period led to the construction of a multipurpose building for the Centre, increased enrollment and expanded the funding base for the Centre's operations. Under the project, an innovative Seed Science and Technology programme was introduced at the Master's level.

After 12 years of preeminence in the plant breeding education space and a frontrunner in the ACE project, WACCI was selected as one of the winners of the ACE for Development Impact (ACE Impact) project grant in 2019. The Centre under the ACE Impact project is charting a new path to becoming an "African Centre of Excellence for Agricultural Innovation and Entrepreneurship". Under the leadership of Professor Eric Danquah, guided by the Centre's core values of Excellence, Integrity, Commitment to People, Culture of Mentoring, Accountability and Shared Governance, WACCI has put together an excellent multidisciplinary team comprising plant and social scientists and seasoned administrators to train the next generation of game-changers and history makers for the transformation of agriculture in Africa as well as address the critical challenges along the value chains of the important staple crops to increase their productivity and accessibility.

WACCI is partnering with the Departments of Crop Science, Agricultural Economics and Agribusiness and Agricultural Extension of the School of Agriculture, UG to run postgraduate programmes in Agronomy, Pathology, Genetics and Plant Breeding, Post-harvest Technology, Horticulture, Agribusiness and Entrepreneurship and Agricultural Extension. These collaborations meet the Centre's aspirations to become an African Centre of Excellence for Agricultural Innovation and Entrepreneurship.

The ACE Impact project aims to train crop improvement scientists and agripreneurs who will stimulate growth in the agricultural sector and will significantly contribute towards food security and socio-economic development; enhance value chains of soybean, maize, tomato, and cassava through the development of new products to increase nutrition and startup companies in emerging markets; enhance research and development in food and nutrition security that directly impacts countries in Sub-Saharan Africa (SSA); increase production of higher-yielding staple crop varieties; increase household incomes through the adoption of improved varieties of nutrient-dense crops; and improve visibility among media and policymakers to impact the decision-making process.

The ACE Team

Management and Governance



Prof. Eric Danquah
ACE Centre Director



Prof. Samuel K. Offei
Assoc. Director,
Research Programmes



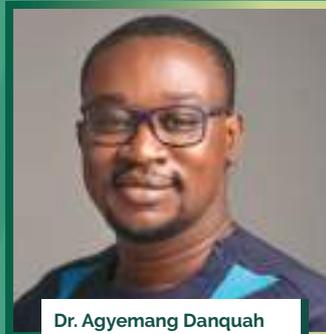
Prof. Kwadwo Ofori
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Dr. Daniel Dzidzienyo
ACE Centre Deputy Director



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Research Team I
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Dr. Beatrice Ifie
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Dr. Gloria Essilfie
Research Team III
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Prof. Irene Agyir
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Mr. Emmanuel Bonaparte
Environmental and Social
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Mrs. Mawulawoe Anato-Dumelo
Senior Research Assistant



Mr. Samuel Reynolds
Lab Technologist



Ms. Isabella Gyimah
Administrative Assistant



Mr. David Arthur
Programmes Officer/M&E Assistant

Sectoral Advisory Board



CHAIRMAN

Mr. Thomas Gambrah
Managing Director, Premium
Food Limited, Ghana



Prof. Eric Danquah
ACE Centre Director



Mr. William Kotey
Managing Director
RMG concept, Ghana



Dr. Solomon Ansah
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Mr. Ben Kemetse
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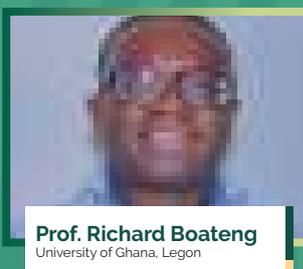
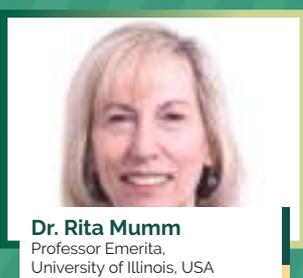
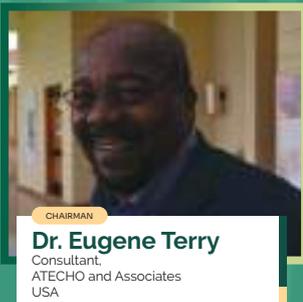


Mrs. Josphine Quagraine
Deputy Director,
PPMED MoFA, Ghana



Dr. Daniel Dzidzienyo
ACE Centre Deputy Director

International Scientific Advisory Board



03 Research Highlights



Microscopes



Flow Hood



RT-PCR System



Rose stock cultures in the growth chamber

Research by Faculty

Soybean Improvement at WACCI for Increased Productivity in Ghana

[Project Team: Dr John S.Y. Eleblu (Biotechnology Centre/WACCI), Prof. Brian Diers (University of Illinois at Urbana-Champaign), Mr Bawa Nutsukpo Efoo (Department of Crop Science), Dr Tatu Seloame Nyaku t(Department of Crop Science), Dr Nicholas Denwar (CSIR-SARI), Prof. Kwadwo Ofori (WACCI), Prof. Eric Y. Danquah (WACCI)]

Soybean [Glycine max (L.) Merr.] is a major protein and oil crop cultivated worldwide. Soybean seeds can be eaten green as a vegetable or mature seed or processed into soymilk and tofu for many culinary uses for protein-rich diets. The seeds are typically processed for oil and meal after harvesting if not used for culinary purposes. Soybean has approximately 40% protein and 20% oil on a dry weight basis. Soybean oil has many uses, the soybean meal is used in many food and industrial products for animal feed formulations. Soybean, like other legumes, is important not only because of their high nutrient content but also because their cultivation leads to increased soil nutrient quality through atmospheric nitrogen fixation in soils that can result in higher productivity of all other subsequent crops. Soybean production has great socio-economic potential and could become an essential component of Ghanaian diets, provide feed for animals, oil and other confectionery products for industry. However, the productivity of soybean in Ghana is limited by numerous abiotic (heat, droughts, salinity) and biotic constraints (seed and soil-borne diseases, leaf diseases and insect pests). The introduction of new soybean genotypes in the country can increase genetic diversity, thereby facilitating the development of new varieties that can address some of the constraints. This research work is a partnership between the University of Ghana, Legon and the University of Illinois at Urbana-Champaign, USA. In this project, key traits essential for the accelerated development of the soybean industry in Ghana considering farmers and consumers' needs have been identified and will be targeted for improvement now and in the near future. This initiative was supported by the Soybean Innovation Lab to select genotypes from the USDA Soybean Germplasm Collection that has been shared with WACCI and Savannah Agricultural Research Institute (SARI), for the development of superior varieties.

The objectives of this study are to:

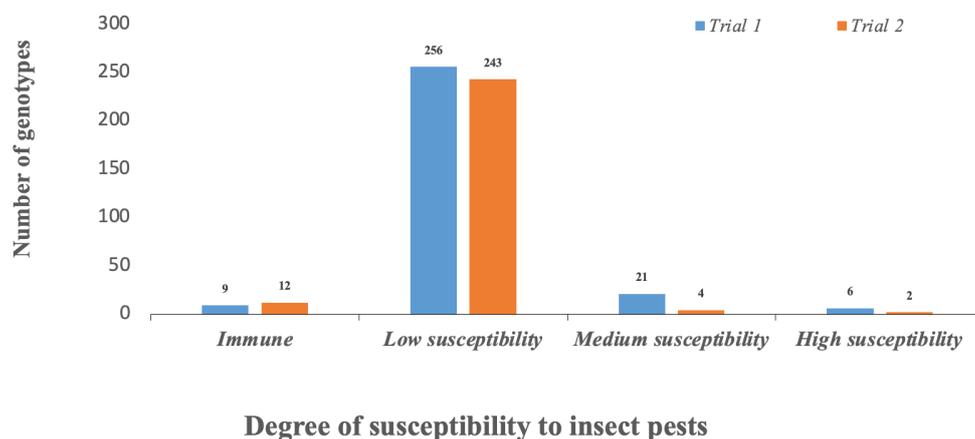
- Assemble and characterize a diverse panel of soybean germplasm for adaptation to the two major agro-

ecologies (the Guinea Savannah and the Coastal Savannah) in Ghana

- Evaluate the soybean genotypes for key target traits including yield, and yield-related traits, as well as pests and disease resistance

In the preliminary study, 313 genotypes were evaluated from the United States Department of Agriculture, USA. The evaluations were carried out in Nyankpala and Bontanga in the Northern region of Ghana. Popular varieties: Jenguma, Afayak and Favour were obtained from SARI and used as checks. An augmented design was used for the two studies. Data was collected on the insect pests and diseases associated with the soybean genotypes and plant growth parameters at the vegetative and reproductive growth stages of the soybean genotypes. The major insect pests were further grouped as defoliators such as variegated grasshopper, *Zonocerus variegatus* Linnaeus (Orthoptera: Pyrgomorphidae), saltmarsh caterpillar, *Estigmene acrea* Drury (Lepidoptera: Erebidae), pod feeders such as green stink bug, *Chinavia halaris* Say (Hemiptera: Pentatomidae), brown stink bug, *Euschistus servus* Say (Hemiptera: Pentatomidae) and sucking pests were soybean aphids, *Aphis glycines* Matsumura (Sternorrhyncha: Aphididae), whitefly, *Bemisia tabaci* Gennadius (Sternorrhyncha: Aleyrodidae). The proportion of genotypes with putative immunity; low, medium, and high susceptibility in trial 1 and 2 are shown in Figure 1. In the first trial at Nyankpala, frog eye leaf spot and bacterial pustule were the diseases identified on some of the genotypes and soybean mosaic virus was observed in the second trial at Bontanga. Eleven genotypes were found to be the best performing in the first trial and 10 genotypes were the best performing in the second trial with respect to the traits assessed. The genotypes identified in this study having good agronomic traits will be further exploited and used in breeding programmes for the development of improved varieties for farmers.

Fig. 1: Distribution of susceptibility of soyben genotypes to insect pests



Biofortification of Cassava (*Manihot esculenta* Crantz) Storage Roots for Nutritional Enhancement with Farmers Preferred Traits

[Project Team: Dr Daniel K. Dzidzienyo (Biotechnology Centre/WACCI), Prof. Irene Egyir, (Department of Agricultural Economics and Agribusiness/WACCI), Dr Gloria Essilfie (Department of Crop Science/WACCI), Dr Joris Gerald Niilante Amisshah (Department of Family and Consumer Sciences/WACCI), Dr Seloame Tatu Nyaku (Department of Crop Science/WACCI), Dr Agyemang Danquah (Department of Crop Science/WACCI), Dr Nana Afranaa Kwapong (Department of Agricultural Extension), Dr Nigel Taylor (Donald Danforth Plant Science Centre, USA), Dr Joseph Adjebeng-Danquah (CSIR-SARI, Ghana), Dr Ruth Thompson (CSIR-CRI, Ghana), Dr Michael Adu (University of Cape Coast), Dr Isata Kamanda (SLARI, Sierra Leone), Dr Prince Norman (SLARI, Sierra Leone), Dr Damian Njoku (NRCRI, Nigeria), Dr Mercy Elorhor Diebiru-Ojo (IITA, Nigeria), Dr Elisabeth Parkes (IITA, Nigeria), Prof. Eric Danquah (WACCI)]

Despite the importance of cassava (*Manihot esculenta* Crantz) as a major starchy staple crop in various developing countries in Africa, Asia and South America, its typical meal-size portion (a 500 g meal) provides only 30% of the minimum daily requirement of iron and zinc and 10% of the daily pro-vitamin A. This is of grave concern as the majority of the growing areas have high incidents of micronutrient deficiencies with children and women of child-bearing age being the worst affected. Biofortification of crops with high macro and micronutrient density has been proposed as a cost-effective, efficient and sustainable way of combating malnutrition. Apart from the human nutrition deficits problem of cassava to consumers, its production also suffers from, systemic diseases caused by viruses, phytoplasmas, bacteria, fungi among other factors that limit the yield potential of cassava genotypes resulting in drastic yield reductions. A

sustainable production of cassava, therefore, depends on the availability and use of disease-free planting materials; and their prompt delivery for increased productivity. Using new and adapting appropriate and innovative tools, technologies and methodologies (TTMs) to engage relevant stakeholders and to speed up breeding and accelerate genetic gains, the project is expected to identify, improve, pilot, and disseminate appropriate genotypes of cassava varieties with high available micronutrients (high total carotenoid, iron, zinc and protein) with complementary high dry matter and starch content and other farmer-preferred traits and new products. The release of these superior cassava varieties in Ghana and the collaborating countries will significantly improve the health and nutritional status of the poor and vulnerable groups, particularly children and women.

Grafting for Disease Resistance Against *Fusarium oxysporum* f. sp. *Lycopersicae* in Tomato Genotypes

[Project Team: Dr Seloame Tatu Nyaku (Department of Crop Science/WACCI), Dr Naalame Amisshah (Department of Crop Science/WACCI), Dr Agyemang Danquah (Department of Crop Science/WACCI), Prof. George Nkansah (Institute of Applied Science and Technology, IAST)]

Tomato production in Ghana is limited by the fungus *Fusarium oxysporum* f. sp. *lycopersicae*, which causes Fusarium wilt, which if not managed early, ultimately leads to complete plant collapse and death. The grafting technology, where susceptible tomato genotypes to *Fusarium oxysporum* are grafted onto other resistant *Solanum* rootstocks, has the potential of higher yield production. This technology can be utilized both in open fields and in the greenhouse systems, however, it is yet to be fully explored by tomato farmers in Ghana. The aim of this research is to access the response of grafted tomato genotypes to *Fusarium* and to determine the incidence and severity of Fusarium wilt, on fruit quality, palatability, and storability of grafted tomatoes. Compatible tomato scions and eggplant rootstocks combinations for tomato production will be identified.

The specific objectives are:

- Determine the compatibility of widely grown tomato cultivar (Pectomech) grafted onto *Solanum* rootstocks (*Solanum torvum*, MongaIT-11 and *Solanum macrocarpon*)
- Screen other potential rootstocks for Fusarium wilt resistance.
- Assess the response of grafted tomato genotypes to Fusarium infestation and plant yield in pot and field environments.
- Determine the impact of grafting on incidence and severity of Fusarium wilt, on fruit quality, palatability and storability

of grafted tomatoes.

- Train farmers in grafting technique, good agricultural practices and Envirodome greenhouse technology.
- One tomato farming region which has a high incidence of the Fusarium wilt disease is Berekum West District of Bono Region, a major tomato growing area. Tomato fields visited in July 2019, showed signs of the organism (whitish mycelia, Fig. 1) and symptoms (browning of vascular tissues, Fig. 2).

Field visits also involved surveys using structured questionnaire to assess farmers' knowledge on Fusarium wilt disease of tomato (Fig. 3).

Soil samples and diseased tomato plants were collected and brought to the Plant Pathology laboratory for fungal isolations, and these will be used in the molecular analysis for determining the presence of races and variants among *Fusarium*-infested tomato plants and soils using specific primers.

Pot experiments have been conducted screening the various rootstocks and grafted tomato plants unto selected rootstocks for Fusarium resistance at the University of Ghana farms. Additionally, field experiments are being conducted using grafted plants in *Fusarium*-infested soils at Brekum.



Fig. 1. Whitish mycelia of Fusarium (red arrow) on a tomato fruit



Fig. 2. Browning of vascular tissue (red arrow), of a cross-section cut on a tomato stem



Fig. 3. MPhil Student (Jennifer Awu) interviewing a farmer at Brekum



Fig. 4. MPhil Student (Jennifer Awu) performing grafting

Developing Heat Tolerant, High Yielding and Consumer-Acceptable Tomato (*Solanum lycopersicum* L.) Varieties for All-Season Production

[Project Team: Dr. Agyemang Danquah (WACCI), Prof. Eric Danquah, (WACCI), Prof. Kwadwo Ofori, (WACCI)]

Tomato production in Ghana is highly seasonal corresponding to the prevailing climatic conditions in the country - specifically the fluctuating temperature and rainfall patterns during the year. Production is therefore restricted to certain times of the year. For instance, the northern regions cultivate tomato from December to April, and the southern regions usually cultivate between the months of May to October when temperature and other climatic conditions would give optimum yields and farmers can get optimum returns. The seasonal nature of tomato production also reflects the cycle of gluts and shortage experienced within the year. Prices of fresh tomato increase considerably during scarce period and plummet during the glut period (Amikuzuno et al., 2012). Major production constraints encountered outside these months (off season) include high day and night temperatures (Nkansah et al., 2003), drought and high incidence of pests and diseases (Jaiteh, et al., 2012).

Tomato has an optimum growth within the temperatures of 18 - 28°C and thrives well under sub-tropical and tropical conditions. The off season is characterized by high day and night temperatures which can reach as high as 40 °C and 26 °C respectively. High temperatures disrupt several morphological, physiological and biochemical processes especially during the reproductive phase of tomato development leading to excessive flower drop and poor fruit set which seriously affect fruit yield (Saeed et al., 2007). The non-availability of heat tolerant tomato varieties remains one of the main challenges of the off-season commercial tomato cultivation in Ghana. As a result, tomato production ceases during a greater part of the year. Tomato production can therefore be sustained throughout

year if genotypes with a higher degree of tolerance to heat stress are available. The objectives of this project are to

1. Assemble a collection of tomato germplasm from diverse sources for conservation and use in future tomato breeding programmes
2. Optimize heat tolerance screening protocol for distinguishing of heat tolerant tomato genotypes
3. Characterize germplasm for heat tolerant traits using both morphological and molecular markers to identify suitable parental lines with superior traits such as disease resistance, high lycopene and improved fruit quality
4. Develop nested association mapping population of heat tolerance and other important traits
5. Discover and characterize important QTLs associated with heat tolerance in tomatoes using NAM populations and DNA markers
6. Develop superior heat tolerance cultivars of tomato for Ghana by marker-assisted breeding.

So far, we have assembled a number tomato germplasm from diverse sources. These accessions will be characterized for heat tolerance by subjecting them under managed heat stress. Identifying heat tolerant genotypes could help understand the genetics of heat stress tolerance in tomato and also serve as donor parent in our heat stress breeding programme to improve farmer-preferred varieties. In subsequent work, we intent to identify QTLs associated with heat stress tolerance in tomato, identify SNP markers for marker-assisted selection and develop superior lines for all year-round production in Ghana.

Developing Frafra Potato (*Solenostemon rotundifolius*) into a Major Food Crop for West and Central Africa

[Project Team: Dr Naalamle Amissah (Department of Crop Science/ WACCI), Dr Francis Kusi (CSIR-SARI), Dr Agyemang Danquah (Department of Crop Science/ WACCI), Dr Romaric Nanema (The University of Joseph KI-ZERBO, Burkina Faso), Dr Joris Gerald Niilante Amissah (Department of Family and Consumer Sciences), Dr Seloame Tatu Nyaku (Department of Crop Science), Dr Denita Hadziabdic-Guerry (University of Tennessee, Knoxville, USA), Prof. Eric Danquah (WACCI)]

Frafra potato, an indigenous tuber crop has the potential to address food insecurity and provide income to producers and collectors of its tubers, most of them women. In Northern Ghana, it is used to bridge the hunger gap during the lean season when major staple crops are not available for consumption. The tubers are a delicacy among children in Northern Ghana. Its high nutrient levels and fairly rich protein source make it a prime candidate for advancement to a major food crop. Unfortunately, most are on the verge of becoming extinct due to very little scientific support and official promotion. Key challenges to its production are the lack of improved varieties, insect pests, and high postharvest losses. Crop improvement should focus on large tuber sizes, increased yields, biofortification with micro-nutrients, and the processing of tubers into value-added products. There is the need to establish a Frafra potato breeding platform that would direct pre-breeding and future breeding efforts in the West and Central Africa sub-region.

Promoting the cultivation of Frafra potato has the potential to support 5 of the Sustainable Development Goals (SDGs 1-End poverty in all forms everywhere; 2-End hunger, achieve food security and improved nutrition and promote sustainable agriculture, 3-Ensure healthy lives and promote well-being for all ages, 8-Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all, and 15- Protect, restore and promote sustainable use of territorial ecosystems, sustainably managed forests, combat desertification, and halt the biodiversity loss).

The specific objectives of the project are to:

- Assess the genetic diversity and spatial distribution of a global collection of Frafra Potato accessions

- Induce and generate useful mutations using gamma irradiation
- Assemble and annotate the gene space of a Frafra Potato reference
- Develop and functionally classify a comprehensive collection of SNPs
- Enhance the resilience of Frafra potato production by integrating pre-and post-harvest management practices
- Determine the speeding breeding (SB) protocol for Frafra Potato
- Develop innovative products, weaning foods, new recipes, and extruded products for the promotion and the utilization of Frafra potato
- Build capacity through graduate training and annual workshops to make full use of developed resources in national breeding programmes

Phase 1 of the project is focused on the first objective Assess the genetic diversity and spatial distribution of a global collection of Frafra Potato accessions, to this effect a coordinated plant out of 405 Frafra Potato accession from Northern Ghana and Burkina Faso have been made and are currently being subjected to detailed phenotypic characterization. We will expand our stock by obtaining additional germplasm from Central and East Africa where the crop is believed to have originated and as well explore the opportunity of obtaining germplasm from other countries in tropical Africa and South-East Asia (including India, Sri Lanka, Malaysia and Indonesia). The genetic diversity and spatial population of the Frafra potato accessions will also be evaluated using both molecular (SSRs) and phenotypic markers.



Effectiveness of Locally Produced Materials on the Quality and Shelf Life of Fruits and Vegetables

[Project Team: Dr Gloria L. Essilfie (Department of Crop Science/WACCI), Louis Quarshie, Richard Osae and Firibu Kwesi Saalia]

Fruits and vegetables are very important in human nutrition. However, their economic value is limited by their relatively short shelf life after harvest. In Ghana, it has been estimated that the average loss after harvesting is between 20% and 50%. There is, therefore, the need to develop and evaluate simple low-cost adaptable preservation technologies that can be used to prolong the shelf life and maintain the quality of fruits and vegetables. The use of surface coating appears to be a promising alternative to the high cost but effective technologies. Our aim, therefore, is to assess the effectiveness of locally produced materials such as neem oil, coconut oil, beeswax, cassava starch and their combination of some quality attributes and shelf life of select fruits and vegetables such as produce, tomatoes, cucumber, chili, watermelon etc. We are also assessing the combined effect of temperature, packaging material and variety on the quality and shelf life of these commodities. The method of application of the edible coating on the fruits and vegetables is also being assessed. It is expected that the results from the study will help in extending shelf life over for all value chain actors to ensure sustained income for them.

The factors are two types of packaging material and 8 types of oil-based edible coatings and their combinations as well as a control. Beeswax is melted and stored at 45°C and coconut and neem oils are kept at 45°C until ready for use. A 5% cassava starch solution is produced using 5g cassava starch in 100 mL water. The solution is heated till it achieves uniform viscosity and allowed to cool down to 45°C. The produce is submerged in the different coatings for 30 seconds, allowed to air dry and placed on Styrofoam plates and covered with either black polythene bags or with transparent cling film. Coated and packaged produce are stored at room temperature (25°C) or cold temperature (4°C). The firmness, refractive index, colour,

pH, weight loss and shelf life of the produce are monitored for 65 days.

Preliminary results have shown that the rate of deterioration of any of the commodities increases with an increasing storage time and temperature. The produce that was not coated (control) deteriorated faster than those that were coated. This could be attributed to the fact that the various coatings regulated the internal gases produced within the produce. The microbial activities that take place when the produce is exposed to normal atmospheric conditions are inhibited by the anti-microbial properties of some of the coatings used. The weight loss generally increased as the storage days increased. However, the weight loss in coated produce was less than the uncoated control. This means the treatments used were able to moderately manage the loss of water as compared to the control experiment. The firmness of the produce under the different treatments at the end of the experiment were significantly different from that of the control. The firmness of the produce stored at room temperature (25°C) decreased faster than that of the produce stored at cold temperature (4°C). This may since cold temperatures reduce the rate of ripening of fruits and vegetables by reducing the climacteric respiration that takes place within some fruits. Beeswax was able to delay the ripening stage of the fruit. This delay caused the produce to maintain its colour for longer. Results obtained indicated that all coatings were effective at preserving the quality of the produce. The shelf life of the fruits was extended with the application of the coating. Produce (mango) stored at 4°C had the longest shelf life of 62 days. Beeswax and its combinations were the most effective in preserving the quality of produce. The surface coatings used in this study were all effective at extending the shelf life and preserving the quality of produce.

Development of high yielding sorghum hybrid varieties with demand driven traits for increased productivity and commercialization using accelerated breeding methods

[Project Team: Dr Beatrice E. Ifie, Dr Theresa Ankamah-Yeboah, Prof. Pangirayi B.Tongoona, Prof. Eric Y. Danquah
Collaborating Institutions: West Africa Centre for Crop Improvement (WACCI), CSIR-Savannah Agricultural Research Institute (SARI), Centre d'Etudes Régional pour l'Amélioration de l'Adaptation à la Sécheresse (CERAAS), Kansas State University and International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)]

Sorghum is an important staple in Ghana contributing to the country's growth and development. However, farmers in the savannah zones are gradually replacing sorghum with early-maturing maize varieties. This is in response to the erratic rainfall pattern coupled with the fact that the traditional cultivars available are long in duration, low yielding and susceptible to diseases particularly the grain mold. Grain mold is caused by a consortium of pathogenic fungal species and poses a severe

challenge to sorghum grain production as well as grain quality. This project is undertaking impact-driven research in sorghum to reduce hunger and poverty through the development of sorghum hybrids with resistance to grain mold. The project is incorporating genomics to speed up genetic gains in developing sorghum hybrids with short duration and resistance to grain mold.



Improvement of Maize for Resistance/Tolerance to Biotic and Abiotic Stresses

Maize (*Zea mays* L.) is an important food security crop amid climate change and the increasing human population in sub-Saharan Africa. Maize plays a vital role in the economy of the country due to its value as a food crop, poultry feed and industrial crop. However, maize is challenged with biotic and abiotic constraints to production. Drought, low soil nitrogen (low N) and maize streak virus (MSV) disease are among the major constraints to maize production.

This project is employing conventional breeding, doubled haploid (DH) technology and marker-assisted selection to accelerate the development and identification of drought, low

N and MSV resistant inbred lines. The combination of Simple Sequence Repeats (SSR) and the targeted-genotyping-by-sequencing (SeqSNP) were used to identify lines with resistance to MSV disease. The SeqSNP was used to validate the presence of quantitative trait loci (QTL) for low nitrogen tolerance. The DH inbred lines are being developed in collaboration with CIMMYT at Kiboko, Kenya from source population from West and Central Africa (WCA). The DH lines will be useful genetic resources for maize breeding programs in WCA for the development of high yielding climate-smart hybrids.



PhD Student generating F1 crosses in the breeding nursery



Rearing of viruliferous leafhopper vector in the greenhouse

Identification of Mutants with Resistance to Fall Armyworm

The Fall armyworm (FAW) is an insect pest of economic importance causing damage and huge losses to maize. Further, the climatic conditions in West and Central Africa offers a conducive environment for the FAW to thrive. Although the use of chemicals has been effective in the control of the FAW, a sustainable and economic alternative such as the use of varieties that confer resistance to the FAW is key for maize production. However, germplasm with sources of resistance

to the FAW is currently not available. Through the process of induced mutation from gamma radiation on selected maize inbred lines, genetic variability has been generated. Three levels of gamma irradiation were used. The M2 mutant lines were artificially inoculated with the larvae and M2 lines with putative resistance to the FAW were advanced to M3. The M3 mutant lines are being validated for the presence of FAW in field conditions.

Establishment of Cowpea Tissue Culture Platform in sub-Saharan Africa

[Project Team: Dr John Saviour Yaw Eleblu, (WACCI) Dr Alison Bentley (CIMMYT), Charline Soraru (NIAB), Melanie Craze (NIAB), Miss Grace Markin (WACCI), Mr Samuel Reynolds, (WACCI) Mr Patrick Bonney (WACCI), Dr Naalamle Amissah (Department of Crop Science/WACCI), Emma Wallington (NIAB), Prof. Eric Danquah (Project Oversight at WACCI)]

Throughout sub-Saharan Africa (SSA), cowpea (*Vigna unguiculata*) popularly known as beans in Ghana is an important multi-functional legume crop consumed as grain (seed crop), vegetable (leaf crop) and feed for livestock (fodder crop). As a hunger-season crop, harvested before staple cereal crops, it is an important component of smallholder food security and over 90% of cowpea production occurs in the semi-arid regions of Africa (FAOSTAT, 2014). Although a very important crop, yields remain low due to a myriad of biotic and abiotic constraints on-field and after harvest. Under this project, we are working towards improving the productivity of Cowpea under these constraints by screening indigenous West African varieties of Cowpea for amenability to tissue culture and plant transformation techniques as a first step towards addressing some of these issues that require genetic engineering. The main objective is to develop platforms for the genetic improvement of cowpea in Ghana for the SSA region which will serve as a major resource for training, research and developmental projects. Our initial National Institute of Agricultural Botany (NIAB) - West Africa Centre for Crop Improvement (WACCI) collaborative project (2017 GBP 20,000 ALBORADA project RB86330 on "Establishment of tissue culture and genetic transformation for scalable cowpea improvement in sub-Saharan Africa") has now developed a pipeline for implementing reliable and reproducible tissue culture in Ghanaian cowpea accessions at NIAB and tissue culture regeneration at WACCI. This allows for the production of whole cowpea plants from cotyledonary (embryonic seed leaf) nodes from 4-day-old germinated seeds. Single shoots are rooted in jars of growth medium and

transferred to pots for further growth allowing the seed to be successfully set under controlled environment conditions. Based on a rapid screen of 14 Ghanaian cowpea accessions (selected by WACCI to represent the diversity of material currently grown by farmers in Ghana (Fig 1)) 'Rec 064' accession was identified as having high levels of germination, the efficiency of regeneration in tissue culture and transformation potential as shown in Fig. 2 (based on numbers of shoots generated per explant).

In 2018, we secured additional funding of GBP 20,000 from ALBORADA to upscale our current research and continue our exciting progress towards a comprehensive and reproducible cowpea transformation pipeline. At the University of Ghana, we have established tissue culture methods for regeneration of Cowpea using shoot tip, cotyledonary node, radicle and leaf explants and also, we have tested the use of organic additives (coconut water, orange, banana and tomato juices) as a substitute for costly synthetic compounds/hormones used for inducing regeneration of plants in vitro. Based on qualitative and quantitative data, cowpea genotypes Tintinwa B and Rec 64 were the most amenable to cowpea in vitro regeneration using organic additives. MS basal media supplemented with coconut additive best-supported cowpea regeneration in vitro by producing 12 cowpea plantlets (Fig. 4 - 6), media supplemented by banana extract produced 2 plantlets, orange plus MS boosted root formation and tomato juice failed to regenerate cowpea genotypes and 5 cowpea plantlets were regenerated on the control media MSB5.



Fig.1: Ghanaian cowpea accessions for tissue culture testing



Fig.2: Staining (blue) shows early evidence for transformation in 2-month-old shootlets



Fig.3: Cowpea seeds germinations in vitro after 1 week of culture. Ready for explant excision.



Fig. 4: Regenerated cowpea on MS media supplemented with coconut extract at 5 weeks of in vitro culture.



Fig. 5: Regenerated cowpea on MS media supplemented with coconut extract at 5 weeks of in vitro culture.



Fig. 6: Regenerated cowpea plantlets at 5 weeks old transferred to acclimatization chamber.

Product Commercialization

The WACCI maize improvement programme through funding from AGRA developed and released three white maize hybrid varieties in 2019 after meeting the requirements of the National Varietal Release and Registration Committee. The hybrids (Aburo Legon, Abeefo Aburo and Akuafo Aburo) with a yield potential of 9 to 11 t/ha are the best performing hybrids locally released and available to Ghanaian farmers. These hybrids have the potential to more than double the national average if adopted. In Ghana, the current national maize yield is estimated at 2 t/ha which is about 20% of the potential yield achievable. This low yield among other factors is attributed to the use low yielding varieties, mainly open-pollinated varieties, and minimal use of quality hybrid seeds. Several hybrids have been released in Ghana, but none has undergone full commercialization. To make available these hybrids to farmers, WACCI adopted a public-private partnership (PPP) model with Legacy Crop Improvement Centre (LCIC), a private seed company to enhance the availability of high-quality certified seed to promote the adoption of the hybrids in Ghana.

WACCI, through its strategic partnership with LCIC, is delivering high-quality certified seed of WACCI hybrids to farmers in Ghana and the West African sub-region. As part of the commercialization drive, WACCI has organized hybrid seed production training for seed producers, conducted several farmer fields schools and established demonstration trials at strategic sites within Ghana. The WACCI-LCIC model is now being piloted with the Integrated Water and Agricultural Development (IWAD), a private seed company and Crops Research Institute (CRI) and Savannah Agricultural Research Institute (SARI) both of the Council of Scientific and Industrial Research to include other crops such as soybean, cowpea and groundnuts. The project titled "Ghana Early Generation Seed Consortium for Sustainable Production of Quality Seeds" is funded by USAID through an award from the Alliance for a Green Revolution in Africa (AGRA) and its partners under the Partnership for Inclusive Agricultural Transformation in Africa (PIATA). A public-private consortium (PPC) is encouraged to address urgent issues affecting the agricultural value chain and to drive the commercialization of products in Ghana.



Research by Cohort 9 PhD Students

WACCI welcomed Cohort 9 PhD students in January 2016. The students, who received their doctorate degree in Plant Breeding in November 2020, come from eight countries in Africa: Ghana, Burkina Faso, Niger, Sierra Leone, South Sudan, Malawi, Ethiopia, and Togo.

NATHAN ALIEL KACHIGUMA - MALAWI

Genetic improvement of common bean (*Phaseolus vulgaris* L.) for tolerance to low soil moisture and phosphorus

The study on Common bean (*Phaseolus vulgaris* L.) is mostly constrained by drought and low soil fertility in particular low soil phosphorus. The objectives of this study were to:

- Assess farmers' perceptions on drought and low soil fertility, coping strategies and preferred traits of common bean;
- Determine the variability of root traits, seed weight and genetic inheritance of root traits in common bean for tolerance to low soil moisture and phosphorus.

It was observed that farmers (24.5 %) in the study cultivated beans in the rainy season and would therefore benefit from improved varieties if adopted. However, drought under rain-fed production and low soil fertility were major constraints (31.7 %) to high seed yield and the impact was rated high (74.8 %).

Deforestation (81.3 %) was one of the major causes of drought and soil erosion, as such, farmers implemented afforestation (44.6 %), practised conservation agriculture and cultivated improved common bean varieties (32.4 %). However, farmers (91.4 %) were not involved in variety development, but they preferred good (creamy) taste (61.2 %), short cooking time (25.2%), red mottled bean grain colour (13.6 %) and determinate plant type (95.7 %) for further crop improvement. Potential tolerant genotypes to low soil-P found were BFS-29, USRM-20 and SEF-15 based on percent reduction in seed weight and low fertility susceptibility index. Genotypes BFS-95 (P1) and Kabalabala-UBR (92)25 (P2) were crossed to generate the F1, F2, BC1.1 and BC1.2. The potential tolerant genotypes identified, genetic variability and gene effects observed can be utilised to develop high seed yielding genotypes with root traits for tolerance to drought and low soil-P through recombination crossing followed by screening and selection in later generations for high seed yield, root and other preferred traits.

BEDASA MEKONNON DOSHO - ETHIOPIA

Genetic analysis of quality protein maize (*Zea mays* L.) Inbred lines under low and optimum soil nitrogen environments in Ethiopia

Quality Protein Maize (QPM) is high in lysine and tryptophan, two amino acid essential for humans. QPM plays an important role in addressing malnutrition in countries where maize is consumed as a major staple. The objectives of this study were to:

- Determine genetic diversity among quality protein maize (QPM) and non-QPM maize inbreds under low and optimum N environments;
- Determine combining ability and heterosis of QPM inbreds for grain yield and other agronomic traits under low and optimum N environments;
- Identify single cross QPM hybrids with high grain yield

performance and yield stability under low and optimum N environments, and (iv) estimate combining ability of QPM inbreds for tryptophan and kernel modification score under low and optimum N environments.

Inbred lines BQL36, VL06373, TL145744, BQL95 and BQL56 were identified as high yielding under optimum N while inbred lines VL06373, BNL79, BQL8, BNL86 and TL147070 were high yielding under low N. Under low and optimum N, non-additive gene actions were more important than additive gene action for grain yield and most traits. Three hybrids TL155976 x TL156583, TL156583 x TL155932, and TL156579 x TL156583 were identified as stable genotypes across the N environments. The contribution of GCA, SCA and reciprocal effects were significant for tryptophan, endosperm modification score, protein and protein quality index (QI) indicating quality traits inheritance under low and optimal N were controlled by both additive and non-additive gene action.

PEARL ABU - GHANA

Genetic analysis of extra-early yellow and orange quality protein maize (*Zea mays* L.) inbred lines under low nitrogen and striga stresses

Developing extra-early quality protein maize (QPM)-provitamin A hybrids with low soil N tolerance and Striga resistance is crucial for addressing the food security and malnutrition challenges in Africa. The objectives of this study were to:

- Assess the genetic diversity among extra-early yellow QPM and orange QPM-provitamin A maize inbred lines
- Identify low N tolerant inbred lines
- Determine the gene action for grain yield and other traits under low N, Striga, and optimal environments
- Assess the performance and stability of selected hybrids under low N, Striga infestation and optimal conditions
- Identify markers and candidate genes

associated with low N tolerance

Twenty-four lines with optimum tryptophan content were selected to develop ninety-six single cross hybrids using the North Carolina design II (NCD II). One hundred and sixty inbred lines were phenotyped under low N and genotyped with 2500 SNP markers for the marker-trait association study. Fifteen SNP associated with low N tolerance traits were identified. The inbred lines TZEEIORQ 73A, TZEEQI 392, TZEEQI 394 and TZEEQI 408 combined low-N tolerance with optimal levels of tryptophan. Additive gene effects were preponderant over non-additive effects for grain yield and most agronomic traits under low N, Striga-infested and optimal conditions. TZEEIORQ 58 x TZEEQI 397 was identified as a high yielding and stable hybrid across the environments and should be broadly tested in multiple environments for commercialization in sub-Saharan Africa.

WENDM YGZAW GESESEW – ETHIOPIA

Genetic studies of maize (*Zea mays* L.) for high plant density tolerance

The use of high plant density tolerant hybrids was one of the major interventions that increased maize yield in the developed world. However, not much has been done on the improvement of the high plant density tolerance of maize in the developing world. Therefore, this study was undertaken to:

- Identify promising inbred lines for high-density planting;
- Evaluate the performance and stability of maize hybrids under different plant densities; and identify promising hybrids for high-density planting;
- Determine the relationship of the per se performance of inbred parents and hybrids on high plant density tolerance;
- Determine the association between maize traits and high plant density tolerance;
- Determine the gene action that controls different traits of maize under high plant density.

hectare). Ten inbred lines were selected based on their yield performance and other agronomic traits which are associated with high-density tolerance. The selected ten inbred lines were crossed among each other in a half diallel mating design to produce 45 F1 hybrids which were evaluated under the three densities. Six inbred lines (87036, EXP124, M131, TZDEI501, TZEI1, and TZEI87) performed better under the high or medium plant densities in terms of yield. The yield performance of hybrids was dependent on plant density and environments. The highest yield of 9.5, 9.2 and 8.6 t ha⁻¹ were obtained from the high plant density and was 26.7, 22.7 and 30% more than the respective yields under the low density. CML16 x TZEI1 and M131x CML16 were the most stable hybrids under the high plant density. It was observed that hybrids with longer ears and filled ear lengths, wider ear diameter and at the same time with high chlorophyll content were more tolerant to high plant density. Both additive and non-additive gene effects were important for yield and selected yield components with additive gene action being more important than non-additive gene action for all traits tested under the high plant density. This study demonstrates the potential for high-density planting of maize in Ghana to increase yield per unit area.

Forty inbred lines were evaluated under three plant densities (low = 53,333, medium = 66,666 and high = 88,888 plants per

LUKA A.O. AWUTA – SOUTH SUDAN

Development of maize lines resistant to maize lethal necrosis using marker-assisted backcross and doubled haploid techniques

Maize Lethal Necrosis (MLN) has emerged as the most challenging disease of maize in the east and central Africa with yield losses of up to 100% in severe cases. Although MLN was first reported in sub-Saharan Africa in 2011 in Kenya, the disease quickly spread within eastern and central Africa including South Sudan. Commercial lines used in South Sudan are highly susceptible to MLN. Given the urgency of the need for MLN resistant varieties by farmers in South Sudan, incorporating modern breeding techniques could effectively reduce the time required to develop new maize lines with enhanced levels of resistance to MLN. Therefore, this study was carried out to:

- Introgress alleles for resistance to maize lethal necrosis into genetic backgrounds of adapted but susceptible lines;
- Validate QTL conferring resistance to MLN using different genetic backgrounds;
- Compare relative efficiencies of transmission of MLN resistance genes between Backcross (BC) and Doubled

Haploid (DH) techniques; and

- Determine combining ability of selected BC₃F₂ and DH lines for yield and resistance to MLN.

The present study generated 13 superior BC₃F₂ lines fixed for favourable alleles of two major QTL for resistance to MLN and 57 DH lines homozygous for 6 loci associated with major QTL for resistance to MLN. The lines were crossed to two elite but susceptible single cross testers and the three-way hybrids were evaluated across artificial MLN inoculations, low soil nitrogen and optimum conditions across Kenya and South Sudan. Hybrids DH70, DHL43, DH18, DH40, BH28 and BH01 showed good performances under artificial MLN inoculations and yielded consistently higher across management options. Lines including BCL5, BCL9, BCL13, D2, D55 and D60 demonstrated more significant negative GCA effects for MLN and positive GCA effects for yield than the testers. The study observed the performance of DH lines per se and in hybrid combinations across environments compared to the BC₃F₂ lines. Using different genetic backgrounds, the study detected seven major QTL populations on chromosomes 1, 3, 5 and 6 on a similar confidence interval (CI) as those reported in previous studies. Three new major QTL for resistance to MLN were identified.

GMAKOUBA TIGHANKOUMI - TOGO

Genetic improvement of cassava (*Manihot esculenta* Crantz) for cassava mosaic disease resistance in Togo

Although cassava is a major food security crop for rural communities, its production in Togo is seriously constrained by Cassava Mosaic Disease (CMD), a disease caused by begomoviruses transmitted by the whitefly (*Bemisia tabaci*). This study was undertaken to characterize cultivated cassava and develop high yielding CMD resistant varieties in Togo. Results from PRA studies revealed that farmers perceived inadequate capital, cassava mosaic disease, deterioration of cassava roots after harvest, inadequate processing methods and the non-availability of clean cassava planting materials to be the prime constraints to cassava

production. The results also showed that yield, early maturity,

resistance to pest and disease, delayed deterioration of roots after harvest, dry matter content, poundability and taste were the most valued selection criteria by farmers. CMD was perceived as the major disease-causing yield losses, and various causes and management practices were associated with the disease. The analysis of 24 F₁ segregating families composed of 2850 progenies revealed a considerable amount of variability within and among families for diseases and agronomic traits under selection. The most diverse traits contributing to the families' variability were CMD resistance, plant vigour, number of roots per plant, number of commercial roots per plant, above-ground biomass, fresh root yield, harvest index and the root dry matter content. High heritability and genetic advance expectations were observed for most of the disease and agronomic traits. There was high genetic variability among the F₁ seedling populations, with great potential for the selection of a group of genotypes to be used either as varieties or for hybridization.

BASSIROU SANI BOUBACAR GAOH - NIGER

Genetic studies on grain iron and zinc concentration and agronomic traits in west African pearl millet [*Pennisetum glaucum* (L.) R. BR.] germplasm

Pearl millet is the most important staple crop for millions of people in the Niger Republic. Germplasm biofortified with iron and zinc is now available but there is limited information on farmers' varietal preferences and production constraints, gene effects controlling the inheritance of iron and zinc concentration and other agronomic traits, heterosis and hybrid stability. The results from PRA studies conducted showed that farmers' preferred traits were long panicle, high seed set, earliness, bigger and white grains. Among these traits, long panicle and high seed set were the most preferred. The most

important pearl millet production constraints were poor soil fertility followed by drought and the parasitic weed striga. The relatively high proportion of GCA effects over SCA effects with the predictability ratio close to unity from the study revealed that grain iron and zinc concentration, flowering, plant height, panicle length, panicle girth, panicle compactness and downy mildew incidence were predominantly under additive gene actions, while grain yield and thousand-grain weight were predominantly under non-additive gene action. A high positive correlation was found between grain iron concentration and grain zinc concentration, which may imply that these traits can be improved by selecting for only one of them. The parental lines identified in the study could be used to develop hybrids, synthetic varieties and open-pollinated varieties by National Agricultural Research Systems (NARS) and international research institutes (ICRISAT).

VANGAHUM, JULIANA MARIAMA – SIERRA LEONE

Genetic studies of salinity tolerance of mangrove rice varieties in Sierra Leone

Rice is a major food crop in Sierra Leone with a high per capita consumption of 104 kg annually. Some rice farmers in Sierra Leone cultivate rice on mangrove swamps, which are highly associated with salinity, resulting in the low average yield (tonnes per hectare). Salinity is major abiotic stress devastating rice production in saline soils, including the mangrove ecology. The study identified high cost of labour, salinity, lack of credit, lack of access to improved seeds and fertilizer, crab damage,

pest and diseases as the most important and major production constraints. The study identified two major QTLs for time to 50% flowering on chromosome one, one major QTL for the same trait on chromosome two. Also, two major QTLs for plant height were identified on chromosome one. The study also revealed that three salt tolerance indices STI, DMP and TSI had discriminated among rice populations for yield under saline field conditions. Five agronomic traits including days to 50% flowering, plant height, number of tillers, number of panicles and filled-grain showed strong and positive correlations with grain weight hence are good selection indices under salt stress. The findings could provide useful information for breeding for salt tolerance in mangrove rice in Sierra Leone.

OUSSEINI ARDALY ABDOU - NIGER

Genetic studies and related agronomic strategies for striga control in sorghum [*Sorghum bicolor* (L) Moench] production in Niger

Striga hermonthica is a harmful obligate hemiparasite of cereal crops that limits sorghum cultivation in Niger. Thus, over the years, several control methods including ethylene gas utilization, nitrogen and fertilizer application, crop rotation, etc. were tested around the world, however, these control measures remain inadequate as they are not accessible to smallholder farmers with limited resources. The development of striga resistant sorghum varieties with farmers preferred traits is the best strategy to minimize striga damage on smallholder farms and contribute to food security. The objectives of this study were to:

- Determine sorghum production constraints and farmer preferences for improved sorghum varieties in Niger;
- Assess available sorghum genotypes for high yield and *Striga* resistance in Niger;
- Establish the effectiveness of Diammonium phosphate (DAP) and Sesame (*Sesamum indicum*) in controlling *Striga*;
- Determine the breeding potential of sorghum populations for *Striga hermonthica* resistance and grain yield.

A participatory rural appraisal (PRA) study was carried out to identify farmers preferred varieties and traits, and sorghum production constraints by interviewing and having focus group discussions with 200 sorghum growers at Maradi and Tahoua regions. Respectively, 55% and 43% of the growers in Maradi and Tahoua were affected by rainfall scarcity and *striga* attack. Among the growers, 31% of the farmers in Tahoua and 19% in Maradi indicated that they were affected by the weed. The DAP level one micro-dosing (2 g) applied alone and the sesame level two (1.5 g) application alone significantly reduced *striga* emergence and distribution. The interaction of sesame and DAP also increased grain yield. The genotypes P9401, P9403, Brahan, S35, CE-151-262, P406 and TXN13/BC3F5-41 were found to have high yield with medium height, a high number of panicles, high grain weight and highly resistant to *Striga*. Two breeding population were developed by crossing P9401 and Eltsedaoua and also Mota Maradi with F2-20. The backcross populations were then evaluated in two different locations in the Tahoua region, for yield and tolerance to *Striga*. The populations BC1F2 (P9401 X Eltsedaoua) and BC1F2 (F2-20 x Mota Maradi) were selected as sources of *Striga* resistant lines based on the selection criteria used. Findings of this thesis have paved the road for a strong future breeding program in Niger to reduce sorghum yield loss due to *Striga hermonthica*.

04 Extension and Community Engagements



WACCI engaging farmers in farmer field school in Greater Accra



Prof. P. Tongoona demonstrating row planting of maize



Cowpea and Maize value chain workshop

Farmer Fields Schools and Value Chain Workshops

Food and nutritional insecurity can be addressed through the training of farmers on the sustainable intensification of crop production using genetically improved seeds, good agronomic practices and innovations to increase on-farm yields. WACCI's African Union -European Union sponsored project has delivered training to a total of 3,219 farmers in three countries in West Africa (Ghana, Nigeria and Burkina Faso) since its inception in late 2018.

This year alone, despite the challenges of COVID-19, 1,801 farmers have been trained in demonstration plots and farmer field school programmes in the target countries. This initiative has empowered and supported these farmers to increase farm yields of key food security crops namely: Maize, Tomato and Rice. Farmers have been trained through participatory approaches and exposed to the use of superior germplasm that are adaptable to biotic and abiotic stresses.

Due to the complex nature of agriculture in Africa, a multi-stakeholder approach is required in understanding the problems and designing sustainable and scalable solutions especially in providing innovations for the development of enterprises which will result in the creation of jobs and improvements in the livelihoods of the youth in Africa.

In this vein, under WACCI's African Union -European Union sponsored project, a series of value chain workshops were initiated in 2019. The crop focused multi-stakeholder workshops were organized on Cowpea (twice in Ghana), Maize (twice in Ghana) and Rice (once in Ghana); on Tomato (in Nigeria); and on Rice in Burkina Faso. These activities were led by WACCI faculty in collaboration with alumni of WACCI who are experts on the focus crops in Ghana and partner countries.

Sustainable Rice Intensification in Burkina Faso

About 800 rice farmers were trained in the Farmer Field School to close the rice yield gap between researchers and farmers. Good agricultural practices including a Sustainable Rice Intensification (SRI)-inspired technology package were introduced to farmers. Farmers were also introduced to high-yielding and high-value rice varieties. One of the two plots used for the demonstration was cultivated like a farmer's field while the other was cultivated according to SRI prescriptions. Thirteen extension officers were involved in the training programmes and they also benefited from the knowledge and skills shared across thirteen different sites throughout the programme in Burkina Faso.

Following the training, the following observations could be deduced:

- Farmers have noted a very significant benefit in terms of seed saving of more than 50% using the technology package;
- Farmers also observed better tillering of the rice with a better vigour of the plants with the teaching technique;

The farmers were impressed by an increase in yields ranging from 50 to 80% depending on the rice varieties.

Sustainable Tomato Production in Nigeria

Researchers adopted a participatory approach in developing the modules to be taught at the Farmer Field School. This approach became apparent during the baseline study where researchers were able to identify the crucial needs of potential farmers who needed this project to sustainably increase their production. In total, 69 extension agents and 490 farmers were involved across the 5 selected states in Nigeria.

Sustainable Maize Production in Ghana

Several factors plague maize production in Ghana such as using low yielding varieties, poor agronomic management, low input farming, abiotic and biotic stresses, and poor infrastructure.

Farmer field schools were thus organized on maize production upon the realization of the need for farmers to be trained on good agronomic management practices, the use of superior varieties and the appropriate use of chemicals for sustainable intensification. These sessions were conducted in partnership with Agricultural Extension Agents of the Ministry of Food and Agriculture (MoFA).

Major maize growing areas were targeted for the establishment of demonstration plots in the major and minor seasons respectively in 2019 and 2020. Two ultra-high yieldings (9-11 t/ha) of newly released varieties of WACCI hybrids (Aburo Legon, Abeefo Aburo) and one open-pollinated variety (Omankwa) from CSIR-Crop Research Institute were planted in the demonstration plots. These plots served as resources for the training of farmers on good agronomic practices, pest management and the importance of using superior genetic resources and good quality seeds.

Farmer field schools were organized at planting, first fertilizer application and top-dressing and control of fall armyworm. Farmers were actively engaged through the stages of the field school. At the end of the farmer field school, farmers understood the advantages of applying best practices such as line planting instead of broadcasting, timely weeding and fertilizer application etc.

This exercise involved four training sessions through maize planting to harvesting with farmers and extension officers participating in each session. In total, 884 maize farmers and 200 extension officers participated in the farmer field schools across 8 sites in the coastal savannah, transition zone and Sudan savannah zones of Ghana.

Sustainable Rice Production in Ghana

Open field days, demonstration plots and farmer field schools were organized for over 1000 rice farmers across more than 15 different sites in the major rice-growing areas in the Volta, Ashanti and Western Regions of Ghana. The activities involved extension agents and agricultural officers of MoFA. Farmers underwent training on how to use new varieties, good agronomic practices including right planting distances, correct fertilizer application, integrated pest management, good soil amendment techniques, and water management. Farmers were also introduced to superior performing good quality rice varieties that are marketable and rich in nutrients.

Cowpea Value Chain Workshop

WACCI organized two value chain workshops on Cowpea Value Chain development in Ghana and hosted a total of 118 participants during the two workshops. The first workshop, organized for stakeholder engagements in March 2019, was on the "Sustainable Intensification of Cowpea Production and Value Chain Development in Ghana". The workshop was designed for representatives of government and non-governmental agencies, farmers, processors, marketers, and other service providers from the industry. The objective was to discuss relevant issues to the cowpea industry, identify the challenges and highlight the opportunities within the Cowpea Value Chain.

The Cowpea Value Chain workshop brought together a total of 64 actors within the Cowpea Value Chain in Ghana. Participants included representatives from the Ministry of Food and Agriculture (MoFA), the Grains and Legumes Development Board, Farmers, Marketers (e.g., Market Queens), Farmer Based Organizations [e.g., Federation of Young Farmers Ghana, Young Professionals for Agricultural Development (YPARD)], Chamber of Agribusiness Ghana, Seed companies and associations [e.g. M&B Seeds, Vinmark farms, Yonifah Seeds, National Seed Trade Association of Ghana (NASTAG)], companies that offer inputs and other supporting services (OCP Ghana, Farmerline, Syecomp Limited, MBC Africa, Ghana Space Science Institute), Centre for Women and Food Security (CeWaFS), University

for Development Studies, Centre for Scientific and Industrial Research - Savannah Agricultural Research Institute (CSIR-SARI), the Institute of Sustainable Energy and Environmental Solutions and the media.

Following the workshop a policy brief for strengthening the Cowpea Value Chain in Ghana with key recommendations to the government and the industry actors to stimulate the growth of the sector was developed. The key recommendations in the brief were to:

Establish a consortium of partners for the development of the Cowpea Value Chain to develop a 5 to 10-year development plan for immediate implementation;

- Develop policies for data management, research, trade and regulatory systems to set standards;
- Support research, development and deployment of improved seeds and technologies;
- Develop capacity-building programmes for value chain actors; and
- Strengthen and support value chain linkages such as the research-extension-farmer-market linkages.

The second Cowpea value chain workshop was organized at the Holy Trinity Spa, Sogakope, Volta Region, in Ghana. The four-day workshop organized under the theme: "Shaping the Future of Cowpea Value Chain Development in Ghana", sought to create a platform for stakeholders to make firm discussions on the draft policy brief (developed at the first workshop), establish a consortium, plan the next decade for the development of the Cowpea Value Chain by proposing key activities for the consortium and its partners to address critical issues of processing, value addition and financing of the cowpea value chain.

The workshop registered over 54 actors selected from key institutions including cowpea producers, processors, aggregators, marketers, financial and credit institutions; the Ministry of Food and Agriculture, Stanbic Bank, Fidelity Bank, Alliance for Science Ghana, Ghana Chamber of Agribusiness, University of Ghana, Grains and Legumes Development Board (GLDB), and Council for Scientific and Industrial Research (Crops Research Institute and Savanna Agricultural Research Institute), Kwame Nkrumah University of Science and Technology and University of Development Studies, and many others.

At the workshop, the draft policy brief was recommended for publication. In addition, a second draft for a ten-year development plan was developed in consultation with all the value chain actors. Key recommendations of the workshop included: development of joint project proposals to seek funding for the operationalization of the consortium; cowpea product development and diversification to create markets to ensure banking and creditor support systems; the need to continue to mount pressure on the government to take urgent action towards investing in Research and Development (R&D) in higher educational institutions; approach African Union (AU), European Union, IFPRI, IFAD and the FAO to increase funding towards R&D for cowpea and other key staple crops; the need to establish an "African Knowledge Information Systems Center" to keep and manage data for the future and there is the need to bring on board stakeholders absent in the consortium. At the end of the workshop, a consortium of cowpea value chain actors was established under the leadership of WACCI to continue pursuing the actions needed for a more efficient and productive value chain in Ghana.



Rice Value Chain Workshop

The value chain workshop for rice was organized at the CSIR-Crops Research Institute (CSIR-CRI) in April 2019 under the theme: Strengthening the Domestic Rice Industry in Ghana, with over 60 participants drawn from actors along the rice value chain in Ghana. The actors were divided into four (4) main working groups comprising producers, service providers, and policymakers.

The participants identified the following challenges and constraints associated with the rice value chain in Ghana:

- Lack of a functioning seed and land tenure system;
- High cost of machinery and inappropriate land preparation techniques;

- Lack of knowledge on fertilizer application;
- Harvesting techniques and pests and disease control;
- High cost of improved seeds;
- Lack of access to timely credit facilities;
- Poor linkage between farmers and research institutions;
- Poor post-harvest management of rice grains;
- Lack of access to good rice milling machines;
- High cost of well packaged local rice;
- Poor rice marketing strategies;
- Limited enforcement of rice policies;
- Ineffective collaboration among stakeholders;
- Ineffective subsidy programmes.

The major conclusions and recommendations from the discussions and deliberations were summarized under the following action points:

- Improve seed system (access, certification, quality, capacity building for seed industry players);
- Improve Land Tenure System (ownership rights, allocation, litigation);
- Provide machinery (tariff reduction, accessibility);
- Create a national rice policy coordination committee (to see to the reviewing of projects; to avoid duplication and the efficient use of resources);
- Enforce import levy and affirmative policy (increase

importation levy from 20% to 25% and use the increment to set up a Rice Fund for the local rice industry;

- Enforce the affirmative policy which compels importers to purchase 20% of their intended imports locally before acquiring import permits;
- Form and strengthen rice advocacy groups (e.g. GRIB)- Encourage the formation of new advocacy groups and strengthening existing ones;
- Develop and disseminate improved rice technologies (varieties, improved agronomic practices and pest/ diseases management);
- Develop and enforce standards for rice value chains (machinery, Grain quality, products development and packaging, pricing);
- Enhance training centres for actors (researchers, extension agents, marketers, processors, farmers and service providers);
- Enhance access to agricultural finance (special rates for agriculture, timely release of funds and other facilities, educate farmers to keep up with repayment plan);
- Develop an attractive marketing system for local rice (improve branding and open up more rice marketing outlets for grain and products).



Maize Value Chain Workshop

A workshop on "Private-Public Partnerships for the Sustainable Intensification of Maize Production for the Crop's Value Chain" was organized in March 2019 by WACCI. The workshop attracted a total of 105 participants from various stakeholders along the maize value chain representing both the public and private sector. These include research institutions, universities, farmers, seed producers, seed processors, market women, microfinance and consumers. Ten bottlenecks were identified, and recommendations were provided to address the identified bottlenecks. Key challenges

identified by the stakeholders included the low adoption of new maize varieties which was also linked to the lack of information flow between researchers, seed producers and farmers.

From 30th November – 3rd December 2019, a second maize value chain workshop "Strengthening the Maize Value Chain for Increased Productivity" took place with 61 participants in attendance. The participants included aggregators, finance institutions, input dealers, traders/marketers, media, policymakers experimented, processors, producers, researchers and educators. The participants proposed the

establishment of a maize value chain consortium composed of relevant stakeholders to further lead discussions, policy debates and advocacy on issues concerning the maize value chain to address the need for timely availability, affordability and accessibility of certified seeds, capacity building of maize value chain actors, and provision of funding for research.

The outcomes of these workshops provided clear indications of challenges in the availability of early generation seeds to drive the timely availability of certified seeds, as well as in its publicity designed to increase the adoption rate of new and superior hybrid maize.



Demand-led Plant Breeding Workshop

WACCI collaborated with the Syngenta Foundation for Sustainable Agriculture (SFSA), the Crawford Fund, the University of Queensland, ACCI, BecA - ILRI, CIAT and the University of Nairobi, to develop a training manual on Demand Led Variety Design (DLVD).

Using the DLVD manual, WACCI has organized training workshops targeted at imparting plant breeders with the skills to engage stakeholders in the process of plant variety design aiming to improve variety adoption in African agriculture. The participants of the workshop were mainly WACCI alumni. Topics

covered included: Principles of DLVD concept; Visioning and Foresight for Setting Breeding Goals; Understanding Clients; New Variety Design and Product Profiling; Variety Development Strategy and Stage plan; Monitoring, Evaluation and Learning; and Making Use of Investments in New Variety Development.

The workshop constituted part of the Centre's efforts towards re-tooling its alumni on appropriate methods in breeding crop varieties that are easily adopted by farmers.



Kofi Annan Enterprise Hub for Agricultural Innovation – KAEHAI



WACCI's drive to contribute to food and nutrition security on the continent, along with its desire to introduce the youth into conversations on agri-entrepreneurship, led to the birth of the Kofi Annan Enterprise Hub for Agricultural Innovation (KAEHAI). The innovation drive at the hub will be run in partnership with local and international strategic organizations and institutions, that will yield the innovative solutions for agricultural transformation in SSA through entrepreneurship.

WACCI elected to name its Enterprise Hub after Mr Kofi Annan for his instrumental role in giving visibility to youth-empowering projects while serving as Board Chair for the Alliance for Green Revolution in Africa (AGRA), the institution that provided initial funding for the establishment of the Centre. The University of Ghana has endorsed the naming the Hub after one of its most iconic figures and former Chancellor and to immortalize his name in the university, an action which has also been endorsed by the Kofi Annan Foundation through the Annan Estate.

The KAEHAI platform was unveiled in October 2019. The event, hosted by Prof. Eric Danquah, Founding Director of WACCI, was attended by several distinguished guests including Professor Ebenezer Oduro Owusu, Vice-Chancellor of UG,

Dr Sagre Bambangi, Hon. Deputy Minister, Ministry of Food and Agriculture, and H.E. Andrew Barnes, then Australian High Commissioner to Ghana who, through the Australian Government, provided funds to furnish the Enterprise Hub. KAEHAI aims to:

- Provide expertise across a wide range of relevant enterprise and technological spheres to support innovation and product development in key areas of agricultural commodity value chain development/management;
- Provide relevant and appropriate support to companies and individuals wishing to develop new products by giving them access to information and shared services to grow these innovations and new products.

KAEHAI is expected to bring like-minded individuals together to support new and existing enterprises, as well as entrepreneurs with relevant and appropriate ideas, networks and support services. These ideas will drive innovation and new product development for agricultural transformation in sub-Saharan Africa.

06 African Plant Breeders Association (APBA)



WACCI Launches African Plant Breeders Association

WACCI launched the African Plant Breeders Association (APBA) in December 2019. The launch which also saw the organisation of APBA's Maiden Conference was on the theme, "Advances in Classical Breeding and Application of Modern Breeding Tools for Food and Nutrition Security in Africa".

Welcoming over 300 scientists, researchers, national agriculture policymakers, students and professionals from both public and private sectors in the fields of plant breeding and science, Professor Daniel Asiedu, Provost, College of Basic and Applied Sciences, University of Ghana, expressed his gratitude to the Interim Executives of the African Plant Breeders Association for choosing the University of Ghana as the venue for the launch and the maiden International Conference of the Association. He noted that WACCI in the last seven years has produced the highest number of PhD students including international students from across the West and Central Africa sub-regions and beyond. He believed the record would be maintained and improved.

Professor Asiedu recounted that the untapped agricultural potential in sub-Saharan Africa has contributed to extreme poverty and deteriorating food and nutrient security with over 240 million people hungry. Hence, there was the need for a drastic change within the food and agricultural system in sub-Saharan Africa if the region was to attain sustainable development goal 2 which states "End hunger, achieve food security, improved nutrition and promote sustainable agriculture by 2030".

Professor Eric Danquah, who is the Director of WACCI and the Interim President of APBA, in brief remarks indicated that Africa remains the most endowed continent in natural resources and urged Africa leaders to consider trans generational leadership to unlock the African dream and free the next generation to take the continent to the next level.



07 News Highlights

WACCI Holds Maiden Edition of Conversations on Agricultural Innovation and Entrepreneurship at The Kofi Annan Enterprise Hub

The Kofi Annan Enterprise Hub for Agricultural Innovation (KAEHAI) recently hosted Mr Alhassan Andani, CEO and Executive Director of Stanbic Bank Ghana Ltd, for its maiden edition of Conversations on Agricultural Innovation and Entrepreneurship in October 2020.

The programme formed part of a series of agricultural policy dialogues initiated to host agri-business executives, policymakers, politicians, the diplomatic corps, and other influential private persons to discuss issues on the transformation of agriculture in Ghana.

Mr Joseph Gakpo facilitated the discussions between Mr Andani and Professor Eric Danquah, Director of WACCI, on the topic: Funding Agricultural Entrepreneurship and Scientific Innovations: The Role of the Private Sector, Government and Philanthropic Organizations.

Professor Danquah, stressed on the importance of government-private sector collaborations to engage the youth, as well as people with innovative ideas and skills in conversations focused on addressing the entire agriculture value-chain systems in the country. He also encouraged African governments to invest more in research and innovation by establishing agricultural institutions of higher learning.

Mr Andani expressed his need for the government to acknowledge agriculture as an entity capable of driving economic development. While he viewed the Government

of Ghana as the only agency capable of providing the largest financing for agriculture, he acknowledged the private sector's support of the agricultural industry. Mr Andani charged the government to invest heavily into research institutions and ensure that the skills, institutions and market structures were in place. He added that the inability to manage the markets operating at smaller levels made financing extremely risky for the private sector.

"If structures were in place, brilliant ideas from innovative hubs focused on agriculture could easily be nurtured from pilot to commercial stages. Without having these systems in place, programmes like the Grains Development Board, food distribution systems and Stanbic Bank's AGRA-funded limited guarantee loan scheme will not yield the desired results," he said.

Mr Andani mentioned that there were huge business potentials in agriculture and that the private sector, government and philanthropic organisations should continue to support research throughout the agriculture value chain. He pledged to support the organisations of markets together with the government to make Agribusiness and Agri financing meaningful. He commended WACCI for instituting this innovative platform for conversations in agribusiness where its real contributions to national development would be appreciated.



WACCI and MIT Jointly Launch Global Startup Labs Entrepreneurship Programme

WACCI collaborated with the Massachusetts Institute of Technology (MIT) to launch a five-week entrepreneurship programme.

Dr Daniel Dzidzienyo, Deputy Centre Leader of the ACE Project launched the "Global Startup Labs (GSL) Entrepreneurship Programme" aimed at cultivating young technology entrepreneurs in Ghana. He reiterated the Centre's commitment to becoming a hub for agricultural innovation and entrepreneurship. He said not only was WACCI championing issues related to tackling low productivity challenges of staple crops cultivated by smallholder farmers in Africa but it was also leading in the transformation of the seed industry for food security through training of scientists in Plant Breeding at the PhD level and Seed Science and Technology at the MPhil level. Dr Dzidzienyo said that the GSL programme was designed to teach students the necessary skills to create a startup. "We expect that at the end of the training you will use the knowledge and skill to set up businesses that will create jobs and stimulate growth in the economy", he said.

He said that WACCI, under the World Bank ACE Project, was on the path to becoming a world-class ACE in Agricultural Innovation and Entrepreneurship. He stated that this was evident in the establishment of the Enterprise Hub for Agricultural Innovation which would enable the Centre to train young graduates and entrepreneurs.

Mr Ari Jacobovits, Program Manager, MIT-Africa, said that a group of MIT students from African started the GSL. They recognized MIT's framework for teaching entrepreneurship, adopted it and introduced it in other universities. He said that

over the years the programme had taken different forms, themes, and had introduced both technical and agricultural components. Jacobovits, who described the programme as a hands-on project, tasked students to use their framework to create jobs, as GSL had witnessed lots of success globally.

Professor Irene Susana Egyir, Senior Lecturer at the Department of Agricultural Economics and Agribusiness, UG said that achieving Sustainable Development Goal One (Zero Hunger) largely depended on solving agricultural problems. "It is only when we strengthen agriculture that the good quality food will come out, the distribution will be done, and we can sustain food production", she added.

The Coordinators of the WACCI-MIT Global Startup Lab Programme, Dr John S.Y. Eleblu and Mrs Jennifer Saint-Acquaye were excited about the opportunity presented by the partnership to nurture young entrepreneurs and create the needed employment for the youth.

The MIT-founded programme has witnessed over 75% of the attendees continue their startups after participating with over 30 startups still in operation since inception. It entails developing curriculum materials, software technologies, platforms and networks that enable students to innovate in the area of information and communication technologies to solve key problems in Agriculture and Agribusiness. As part of the programme, investors are invited to the final pitch day to assist trainees with the best ideas with funds for building successful start-ups.



Freshmen at WACCI

WACCI welcomed 10 students comprising Cohort 13 of its PhD in Plant Breeding programme for the 2019/2020 academic year. The students are from four African countries; Nigeria, Ghana, Kenya and Ethiopia and are poised to acquire knowledge to help improve food security in Africa. DAAD and the BaNGA Project are sponsoring six and two freshmen respectively. The other two are self-funded with support from the Centre.



Name: Awuku Frederick Justice
Country: Ghana
Crop: Maize
Institute: SARI



Name: Yosef Alemu
Country: Ethiopia
Crop: Yam
Institute: Ethiopia Institute of Agricultural Research



Name: Abiodun Olayinka
Country: Nigeria
Crop: Yam
Institute: Africa Rice Centre



Name: Joan Josephine Cheptoo Kimutai
Country: Kenya
Crop: Maize
Institute: Kenyatta University



Name: Mawulawoe Anato-Dumelo
Country: Ghana
Crop: Maize
Institute: WACCI



Name: Rhoda Gyinae Diawuoh
Country: Ghana
Crop: Maize
Institute: BINARI



Name: Godson Nyawudzo
Country: Ghana
Crop: Cassava
Institute: Central University



Name: Adzigbe Justice
Country: Ghana
Crop: Rice
Institute: Victory Presby JHS



Name: Otu Solomon Ayeboafa
Country: Ghana
Crop: Cowpea
Institute: BNARI, GAEC



Name: Asmamaw Fentaw Abate
Country: Ethiopia
Crop: Sorghum & Maize

WACCI Cohort 9 Students Defend their PhD Theses

Fourteen students of the West Africa Centre for Crop Improvement (WACCI), University of Ghana, successfully defended their PhD theses at oral examinations organized by the School of Graduate Studies (SGS), the University of Ghana from May 25 – 29, 2020. The students who comprised cohort 9 of WACCI's PhD in Plant Breeding programme enrolled in January 2016. External examiners from eight countries in Western,

Eastern and Southern Africa and Columbia in Southern America assessed the students in oral examinations which were hosted virtually by the SGS. The students are expected to graduate by the end of the year. They have all returned to breeding programmes in their home institutions to build capacity for crop improvement, giving credence to the WACCI project: "Training African breeders on African crops for Africa".



WACCI Alumnus, Dr Maxwell Darko Asante Leading IFAD Project to Develop Rice Varieties Resistant to Rice Yellow Mottle Disease

WACCI alumnus, Dr Maxwell Darko Asante, of the Crops Research Institute (CRI), is leading a research project funded by the International Fund for Agricultural Development (IFAD) to improve resistance to the rice yellow mottle and blast diseases in all the popular aromatic varieties of rice in Ghana.

Dr Asante graduated from WACCI in 2013 and has since then released six rice varieties currently grown in farmers' fields across the country. In 2018, he received the National Best Agricultural Scientist Presidential Award at the National Farmers' Day celebration.



WACCI Alumnus Develops Cassava Varieties with Extended Fresh Root Shelf-Life

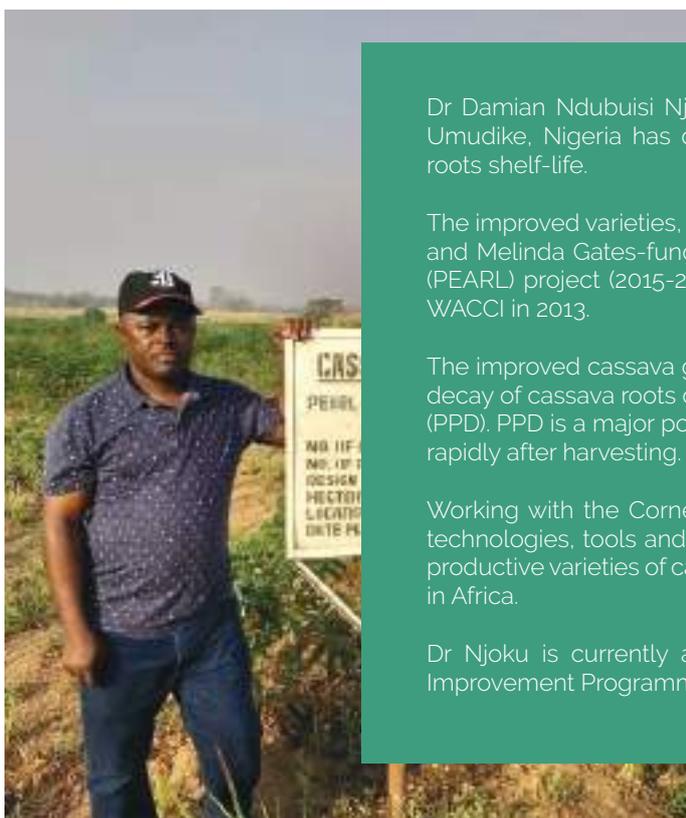
Dr Damian Ndubuisi Njoku of the National Root Crops Research Institute (NRCRI), Umudike, Nigeria has developed promising cassava varieties with extended fresh roots shelf-life.

The improved varieties, which remain fresh 15 days after harvest, were results of a Bill and Melinda Gates-funded Programme for Emerging Agriculture Research Leaders (PEARL) project (2015-2019). The project was led by Dr Njoku, who graduated from WACCI in 2013.

The improved cassava genotypes will help address the problem associated with the decay of cassava roots commonly known as Post-harvest Physiological Deterioration (PPD). PPD is a major post-harvest challenge associated with cassava roots decaying rapidly after harvesting.

Working with the Cornell NextGen and HarvestPlus initiatives and using advanced technologies, tools and methods, Dr Njoku hopes to release resilient, nutritious and productive varieties of cassava to enhance food security in the most populous country in Africa.

Dr Njoku is currently an Assistant Director and the Coordinator for the Cassava Improvement Programme at the NRCRI.



APBA Appoints Working Group for Plant Genetic Resources Management of the ASBA

The African Plant Breeders Association (APBA) recently appointed an 11-member Working Group for the Plant Genetic Resources Management (WG-PGRM) of the African Seed and Biotechnology Association (ASBA).

Plant Genetic Resources (PGR) forms one of the most crucial components of agrobiodiversity, which sustains humankind by meeting the demands for food, fodder, fibre and fuel. In addition to ensuring resilience in food security, protecting the environment, adapting to climate change and reviving lost resources, the PGR is also dedicated to fueling the development of new industrial products as well as new research breakthroughs.

To help fulfil the mission of the ASBA, the WG-PGRM was created to collect, conserve, utilize, and exchange plant genetic resources (plant breeding and seed/planting materials) for production and commercialization. The working group will also foster debate and interaction among stakeholders at national, regional, and continental levels for identifying trends, constraints and emerging issues, as well as provide support for policy formulation and strategy analysis, implementation and monitoring. Ultimately, there will be an improvement in the designing, resourcing and implementation of policies, research and development initiatives.

The group held its inaugural meeting in December 2020.

WACCI Alumni Elected as Members of NPBA's Executive Committee

Two WACCI alumnae, Dr Ijeoma Akaogu and Dr Mercy Elohor Dieburu were elected General Secretary and Assistant General Secretary respectively to the Executive Committee of the Nigeria Plant Breeders Association (NPBA) during the association's General Congress. The two appointees will serve for two years after which they will be eligible for re-election. The Electoral Committee of the association, which oversaw the process was also made up of a WACCI alumna Dr. Dorcas Ibitoye who serves as the Secretary.

One of the major tasks that the Executive Committee sets out to achieve is to ensure that they play an active role in the passing of the Nigeria Plant Breeders Rights Bill. This bill will protect the rights of Nigerian plant breeders, as well as ensure that farmers grow crops with quality, high-yielding seeds. The NPBA was created in October 2019 following the successful launch of the African Plant Breeders Association (APBA) and aims to unify all plant breeders in Nigeria and the Diaspora, who work in research centres, universities, and private institutions.



WACCI Alumna Appointed First Female Representative of Convocation at the University for Development Studies (UDS), Ghana



Dr Sanatu Mustapha Alidu, a senior lecturer at the Faculty of Agriculture, University for Development Studies, has been appointed as the first female Representative of Convocation (Non-Professorial) to the University Council following her victory in an election held in September 2020.

Dr Sanatu was a member of the PhD graduating class of 2018.

WACCI Director to Serve on Board of New \$25m USAID Food Security Initiative



Director of WACCI, Prof. Eric Yirenkyi Danquah, was appointed to serve on the board of a new \$25 million USAID food security initiative. The Cornell University-led initiative called the Innovation Lab for Crop Improvement (ILCI) is a new global food crop research program that will work to deliver enhanced agricultural production tools in developing nations across the world. Prof. Danquah will serve on the External Advisory Committee (EAC) of ILCI. The responsibility of the EAC is to provide oversight for the program much in the same way as the board of directors oversees corporate executives.

The committee will provide vision, managerial guidance, insight and evaluation responsibilities for the program. It will also act as scientific advisors to help identify additional partnership and funding opportunities for the programme.

The five-year initiative will work to advance plant breeding tools, technologies and methods aimed at delivering staple crops that can increase yields, enhance nutrition and ensure greater resistance to pests and diseases. The ILCI will be an integrated research and delivery program with multidisciplinary expertise in cutting edge agricultural development, from plant breeding and machine learning to quantitative genetics and gender inclusion.

WACCI Director Calls for Establishment of National Agric Authority to Transform Sector



Prof. Eric Danquah called for the establishment of a National Agriculture Authority (NAA) to regulate and oversee the transformation of agriculture for socio-economic development under the Ghana Beyond Aid Initiative.

He also called on the government to establish a National Agriculture Development Fund into which funding of at least 1% of Ghana's GDP will be invested to finance the development of the agricultural sector.

Prof. Danquah further encouraged the private sector to contribute to the development of the nation through that fund. He believes that with the authority established by an act of parliament, it will be responsible for the oversight of agricultural education, research, innovation and development, as well as modernize agriculture through the development of commodity value chains.

WACCI-Led Public-Private Consortium Receives Grant

A Public-Private Consortium (PPC), led by WACCI, was awarded a grant of \$600,000 to generate a total of 15.2MT of breeder seed and 116MT of foundation seed of selected crops (maize, soybean, cowpea and groundnuts) to meet the demand of quality seeds for planting in the country. The project titled "Ghana Early Generation Seed Consortium for Sustainable Production of Quality Seeds" will deliver high-quality early generation seeds of maize, cowpea, groundnut and soybean, to be distributed to 300,000 smallholder farmers in Northern Ghana. This project will increase productivity through the provision of high-quality certified seeds from the breeder and foundation seed of maize, soybean, cowpea and groundnuts. The consortium will also establish seed production research fields and demonstration plots to promote the improved varieties of the crops to farmers and other stakeholders. The PPC will also conduct training for seed producers to ensure the maintenance of pure seeds.

Professor Eric Danquah acknowledged that the development of these quality seeds was a result of teamwork coordinated by Prof. Pangirayi Tongoona, Dr Beatrice Ifie and Dr John Eleblu of WACCI and Dr John Manful, an AGRA Consultant. "We cannot address the food security challenge in the sub-region if we do not invest in the development of quality breeder

and foundation seed. The 'Planting for Food and Jobs' flagship programme of the government of Ghana will be a mirage if we do not become self-reliant in quality seeds for planting", he said.

The AGRA Regional Head for West Africa, Mr Forster Boateng commended the Consortium for the quality of the proposal and encouraged the team to strive to meet the project deliverables. The Vice-Chancellor, Professor Ebenezer Oduro Owusu, who signed the agreement on behalf of the WACCI-led Consortium partners, said he was delighted that WACCI had engaged public and private partners to address an urgent challenge in the agricultural value chain.

The Consortium is made up of WACCI, Crops Research Institute (CRI), Fumesua and Savannah Agricultural Research Institute (SARI), Nyankpala of the Council for Scientific and Industrial Research (CSIR), Legacy Crop Improvement Centre (LCIC), Koforidua and Integrated Water and Agricultural Development (IWAD), Accra. The grant funded by USAID is an award from the Alliance for a Green Revolution in Africa (AGRA) and its partners under the Partnership for Inclusive Agricultural Transformation in Africa (PIATA).

WACCI Awards Research Grants to Early – to – Mid-Career Faculty

Five early-to-mid career scientists received the WACCI Research Grant Award to research on 7 priority crops of the Centre (maize, tomato, cassava, cowpea, soybean, Frafra potato and sorghum). The total allocation for this grant is US\$250,000.

WACCI is notable for training Plant Breeders from 13 countries in Africa. The Centre also addresses the challenges in Agriculture in Africa by improving on existing varieties to solve food and nutrition insecurities on the continent. Through the Centre's tireless research, it has released three high yielding maize hybrid varieties under the maize breeding programme which

are currently under commercialization in partnership with the private sector. These maize hybrids yield between 9-11t/ha and are the highest yielding maize hybrids ever released in Ghana and will increase productivity significantly for farmers in the country. The Centre aims to see this same achievement in the sorghum, cowpea, cassava and Frafra potato projects which are also staple crops in West and Central Africa that the Centre's researchers are working on. The Centre is hoping to secure funding from other sources to complement this award to scale up the research results for commercialization.



Biofortification of Cassava (*Manihot esculenta* Crantz) Storage Root for Nutritional Enhancement with Farmers



Development of high yielding sorghum hybrid varieties with demand breeding traits using accelerated breeding methods



Research Focus Developing Frafra potato (*Solenostemon rotundifolius*) into a major food Crop



Developing heat tolerant, high yielding tomato varieties for all year production.



Demand-led Breeding and Innovations Platform in the Improvement of Cowpea (*Vigna Unguiculata* L. Walp) for Sustainable Value Chain Development in Africa

Nane Annan Visits WACCI

Mrs. Nane Annan and her team from the Kofi Annan Foundation paid a visit to WACCI in September 2019. She was hosted at the Centre by Mrs. Mercy Haizel-Ashia, Registrar at the University of Ghana and Professor Eric Danquah, the Director of WACCI.

The purpose of the visit was to have conversations on the proposal to name the Enterprise Hub for Agricultural Innovation after her late husband, Mr. Kofi Annan, a former Board Chair of the Alliance for a Green Revolution in Africa (AGRA) and former Chancellor of the University of Ghana. Professor Danquah said that the University Council had approved the proposal and referred the request to the Kofi Annan Foundation for a no objection before inauguration of the Enterprise Hub.

After fruitful conversations, the delegation commended WACCI for the role the Centre had played in fighting food and nutrition security in Africa and said the Foundation will

give a formal feedback to the University of the request. As Board Chair AGRA, Mr. Annan, on learning about the PhD programme in plant breeding at the West Africa Centre of Crop Improvement (WACCI), University of Ghana, took keen interest in the programme. Prior to his assumption as Chancellor of the University of Ghana, he had visited the Centre on July 30, 2008 to have conversations on the African Green Revolution. Accompanied by his wife, Nane, on that visit, he spent some time inspecting the fields, and discussed research on food and nutrition security with the Directors and faculty at WACCI.

The Kofi Annan Enterprise Hub for Agricultural Innovation will run programmes that will equip the youth with the knowledge and skills needed to turn ideas into agri-businesses needed to transform agriculture in Africa.



Prof. Eric Danquah (middle) with Mrs. Nane Annan (left) and Mrs Mercy Haizel-Ashia (right)

AGRA Board Visit's WACCI

Seven members of the Board of Directors of the Alliance for a Green Revolution in Africa (AGRA) led by the incoming Board Chair, H.E. Hailemariam Desalegn, former Prime Minister of the Republic of Ethiopia paid a familiarization visit to WACCI in September 2019.

Professor Eric Danquah, the Director of WACCI, received the delegation and highlighted the Centre's achievements and challenges in a presentation to the Board. He said that the Centre had grown from an AGRA project into a world-class Centre for formal and continuing education in Crop Improvement.

He said that the University of Ghana had absorbed project staff following the expiry of the AGRA 10-year capacity-building grant and lauded past and present Vice-Chancellors for the support of donor-funded projects in the University. Professor Danquah noted that the Centre currently runs one of the largest PhD programs globally for the training of plant breeders. At that time, the Centre had almost trebled AGRA's initial investment of US\$11.5 million and brought onboard strategic partners like the World Bank and the DAAD of Germany.

The WACCI Director informed the Board that, at that time, WACCI had enrolled 127 PhD and 49 MPhil students from 19 African countries and graduated 81 PhDs and 14 MPhils from 12 countries. Through a new grant from the World

Bank under the Africa Centres of Excellence Impact Project, WACCI was transforming into an Agricultural Innovation and Entrepreneurship Institution. He said that plans were far advanced to establish an Enterprise Hub for Agricultural Innovation to be named after Mr Kofi Annan, former Board Chair of AGRA and former Chancellor of the University of Ghana to immortalize his name for championing the course of the youth during his tenure as the Chair of the Board of AGRA.

H.E. Hailemariam Desalegn, in responding to the presentation, said the Board of Directors elected to visit WACCI in commemoration of the African Green Revolution Forum 2019. He said the delegation had been impressed by the achievements of WACCI and thanked the Director for the update and progress of work taking place at the Centre. He stated that AGRA was committed to the sustainability of WACCI. The President of AGRA, Dr Agnes Kalibata commended WACCI for sustaining its image and assured the Centre of AGRA's commitment.

The Director of WACCI, in his closing remarks, informed the AGRA Board of his election as the Interim President of the African Plant Breeders Association (APBA) and extended an invitation to the AGRA Board Members to the launch and maiden conference of the APBA scheduled for October 23-25, 2019 at the University of Ghana.



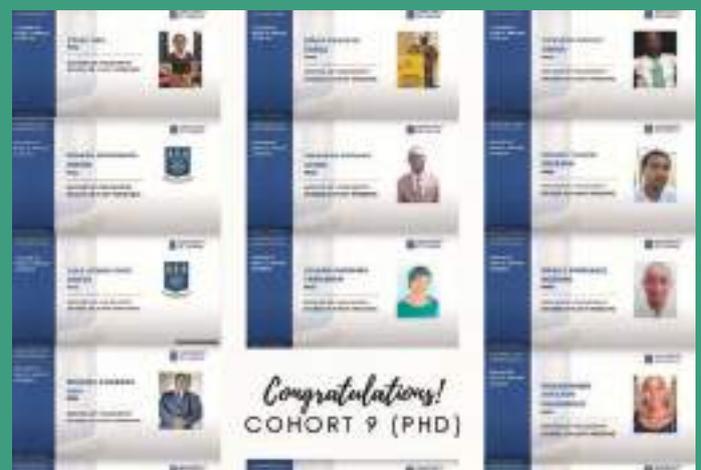
Group photograph with AGRA Board members

University of Ghana Graduates 29 PhD and MPhil WACCI Students

Twenty-nine students of the West Africa Centre for Crop Improvement (WACCI) comprising 14 PhD students from Cohort Nine and 15 MPhil students from Cohort Three graduated from the University of Ghana on November 30, 2020.

There was a total of 130 PhDs conferred at the ceremony out of which 14 of its recipients were from WACCI. The graduates, who received their doctorate degrees in Plant Breeding, come from eight countries in Africa; Ghana, Burkina Faso, Niger, Sierra Leone, South Sudan, Malawi, Burkina Faso and Ethiopia. The

fifteen students awarded MPhil degrees in Seed Science & Technology at the event were enrolled from four countries in Africa namely Ghana, Benin, Nigeria and Mali. The graduation ceremony, held virtually, was in line with national and the university's safety guidelines in response to the COVID-19 pandemic. The Vice-Chancellor of the University of Ghana, Professor Ebenezer Oduro Owusu, charged all graduates to contribute meaningfully and creatively during the global pandemic.



WACCI, AGRA, and Other Partners Launch EGS Consortium for Sustainable Seed Production

The Ghana Early Generation Seed (EGS) Consortium for Sustainable Production of Quality Seeds Project was officially launched in December 2020. The Consortium, led by the West Africa Centre for Crop Improvement (WACCI) is made up of other key partners including CSIR-Crop Research Institute (CRI), CSIR-Savannah Agricultural Research Institute (SARI), Legacy Crop Improvement Centre (LCIC), and the Integrated Water Management and Agricultural Development Ghana Limited (IWAD).

The project, which received funding from the USAID Ghana Mission through an award from the Alliance for a Green Revolution in Africa (AGRA), aims to produce both breeder and foundation seeds for major crop value chains including maize, groundnut, soybean and cowpea. The Consortium will also establish seed production research fields and demonstration plots to promote the improved crop varieties to farmers and other stakeholders. Furthermore, it will conduct specialized training sessions for seed producers. In partnership with the Certified Seed Consortium and the National Seed Trade Association of Ghana (NASTAG), quality certified seeds are

expected to reach an estimated 300,000 smallholder farmers in the major food insecure zones in Ghana: Upper East, Upper West, Northern, North-East and Savannah Regions.

In his opening remarks at the launch, Professor Eric Danquah, and the Principal Investigator for the Consortium stressed its desire to deliver quality seeds to farmers, as well as equip other key actors along the value chain with the required knowledge and skills needed. He further commended the Government of Ghana and the Legislature for passing the Plant Variety Protection Bill in November 2020 and expressed his hope for more innovation through strategic partnerships. "I hope we can open conversations on how the full potential of the so many excellent scientists and private partners in the nation could be exploited for national gain", he said. Boaz Keizire, Head of Policy & Advocacy at AGRA, assured the Consortium of AGRA's continuous support and extended their gratitude to USAID and other partners. He remained confident of Ghana's approach to seed development in improving Ghana's seed value chain.

WACCI Holds Inaugural Meetings of the SAB and ISAB

WACCI held inaugural meetings for its Sectoral Advisory Board (SAB) and the International Scientific Advisory Board (ISAB) members in December 2020. These boards were set up per WACCI's requirements under the African Centres of Excellence (ACE) Impact Project funded by the World Bank. The SAB and ISAB will be responsible for guiding the overall strategy of WACCI in the areas of quality, relevance, collaborations and strategic partnerships needed to meet the objectives of the ACE Impact project and also for the sustainability of the Centre beyond the ACE Impact funding phase.

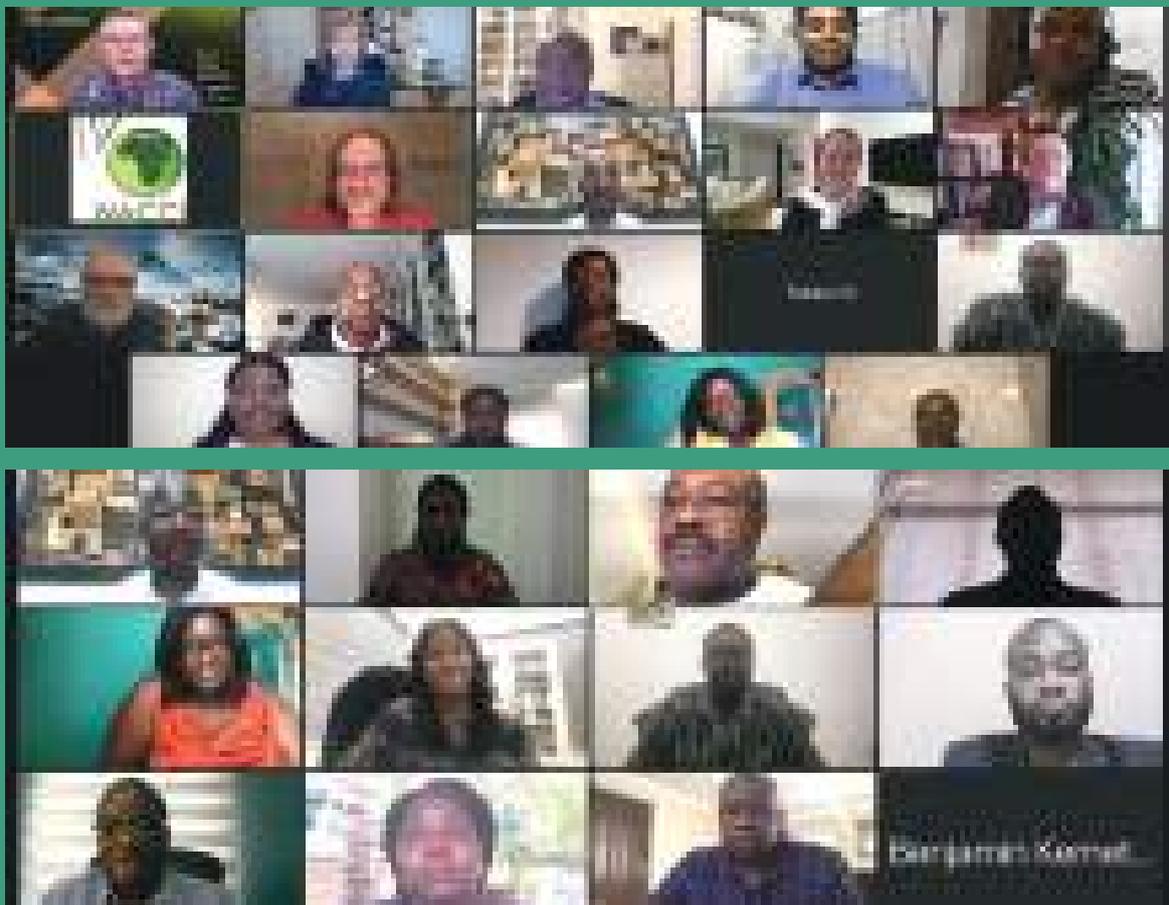
In launching the two boards in virtual sessions, Professor Mohammed Salifu, Director General of the Ghana Tertiary Education Commission, who is also the Chairman of the National Steering Committee of the World Bank ACE Impact Project, mentioned that under the first phase of the ACE project (ACE I), Ghana had three centres including WACCI which was recognized as one of the top and leading performers on various aspects of the deliverables of the project. Under the ACE Impact project, Ghana has 9 Centres of Excellence with three being located at the University of Ghana, he added.

Professor Salifu mentioned that the Centres under the ACE Impact project will be used as nuclei to spawn excellence in

research and graduate studies at world-standard levels. He expressed his gratitude to the SAB and ISAB members for agreeing to contribute towards realising these objectives.

The Director of WACCI, Professor Eric Danquah in keeping the board abreast with developments at WACCI till date mentioned that, the Centre aims to leverage on its ACE I success to maximize development benefits in terms of graduate research and other industry-related activities under the ACE Impact project. He expressed his confidence in the Centre's ability to equip students with the right skills and tools needed to release staple crop varieties to help combat food insecurity in Africa and also equip the youth with the requisite knowledge and skills to birth and nurture ideas, which would grow into innovative start-ups to transform agriculture on the continent.

The chairpersons for the SAB, Mr Thomas Gambah for the ISAB, Dr Eugene Terry, on behalf of their respective board members, accepted their responsibilities and mandate and pledged to work diligently to ensure that WACCI remains globally relevant as a centre of excellence for agricultural innovation and entrepreneurship.



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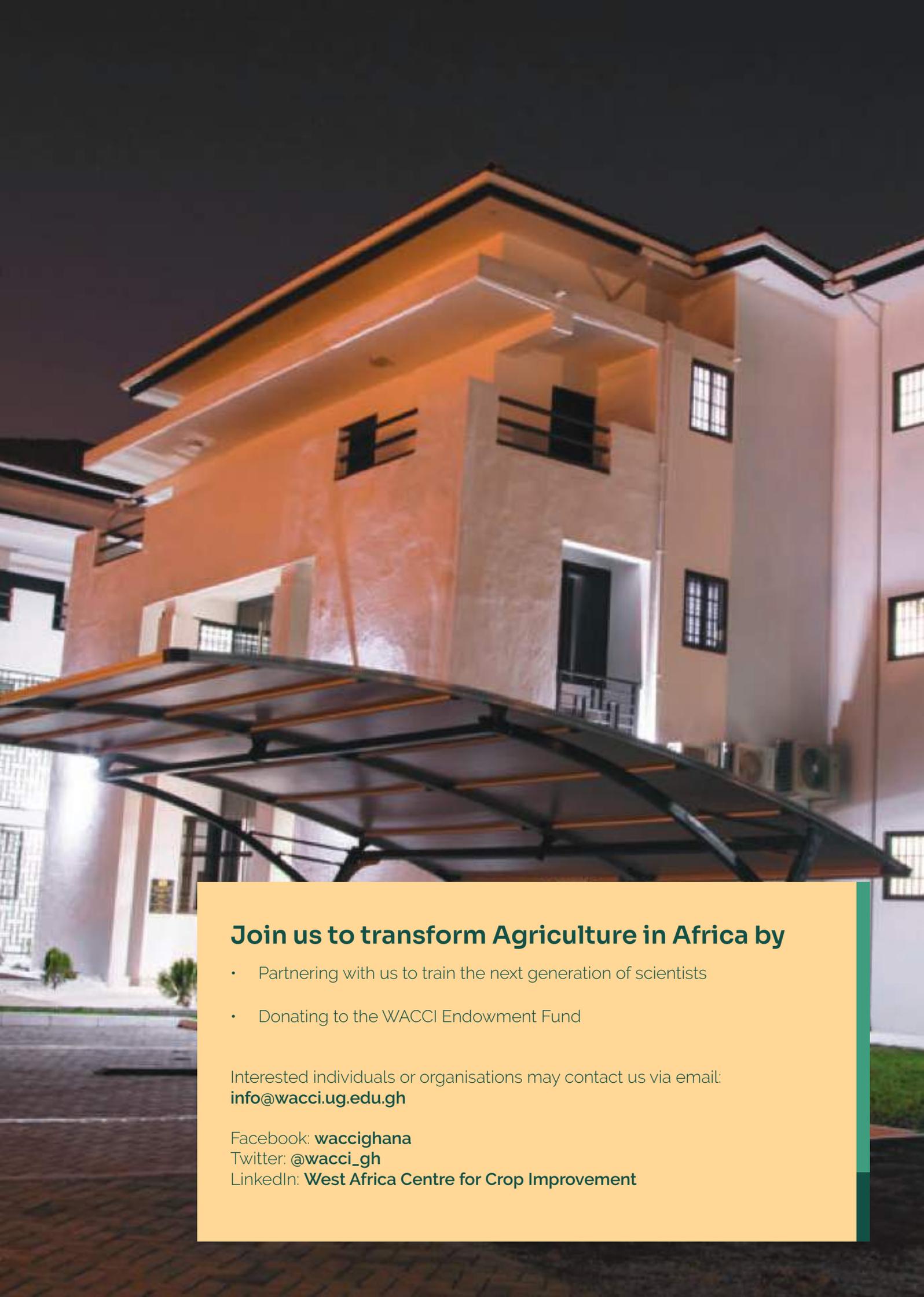
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08 Funding from Donors

Donor	Committed (USD)	Received (USD)
Alliance for a Green Revolution in Africa (AGRA), Kenya	11,449,793	11,449,793
Generation Challenge Programme (GCP), Mexico	667,054	667,054
VW Foundation, Germany	90,960	90,960
Kirkhouse Trust, UK	151,481	110,019
WA Agricultural Productivity Programme	1,625,270	1,297,455
Purdue University, USA	373,032	304,995
Cornell University, USA	1,087,070	710,441
EU Intra ACP Mobility, RUFORUM, Uganda	408,324	348,397
ICRISAT, India	150,000	50,000
Syngenta Foundation, Switzerland	352,084	289,861
AGRA SSTP, Kenya	75,000	74,977
DAAD, Germany	2,787,346	2,281,882
World Bank Africa Centres of Excellence project, USA	13,500,000	6,888,468
Government of Ghana	1,000,000	1,000,000
USAID, USA	668,430	298,131
UQ, Demand-Led Varietal Design, Australia	373,850	382,850
BHEARD, USA	97,166	74,679
Econet, UK & South Africa	600,000	250,000
Syngenta Seeds BV, The Netherlands	142,335	124,850
SLARI, Sierra Leone	299,688	15,000
University of Illinois, USA	25,688	25,688
AGRA Maize Hybrid, Kenya	249,991	249,991
Africa Union-European Union Research Grant	1,000,000	611,832
University of New Hampshire, USA	63,459	63,456
Australian High Commission, Ghana	42,972	42,972
National Root Crop Research Institute, Nigeria	118,398	118,386
African Agricultural Technology Fund, Nairobi	112,336	109,894
Massachusetts Institute of Technology	7,750	7,750
USAID-BHEARD	30,000	15,856
AGRA EGS	600,000	322,676
International Foundation for Science	14,500	14,500
Michigan State University	22,440	11,220
Total	38,186,416	28,304,033

09 Partners





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- Partnering with us to train the next generation of scientists
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