FEED THE FUTURE

The U.S. Government's Global Hunger & Food Security Initiative

Peanut Innovation Lab

Annual Report
Fiscal Year 2020

Feed the Future
Innovation Lab for Peanut

(Peanut Innovation Lab)

Annual Report – Fiscal Year 2020

(1 October 2019 – 30 September 2020)

Peanut Innovation Lab Management Entity
University of Georgia, Athens, Georgia
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Management Entity

The Peanut Innovation Lab Management Entity is hosted by the University of Georgia's College of Agricultural and Environmental Sciences in Athens, GA. Current staff includes Dave Hoisington (Director), Jamie Rhoads (Assistant Director), Allen Stripling (Business Manager), Allison Floyd (Communications Coordinator), Bonnie Klostermann (Administrative Specialist, left in February 2020), Kristen McHugh (Operations Specialist, joined in March 2020) and Jessica Marter-Kenyon (Gender and Youth Postdoctoral Associate).

External Advisory Panel

The External Advisory Panel (EAP) continues to provide feedback on the research progress by participating in project launch meetings and events in-country, as well as reviewing annual reports. Samara Sterling, research director for The Peanut Institute, has agreed to serve on the EAP and provides expertise in the area of peanut nutrition.
Current External Advisory Panel members are:

- Darlene Cowart, Corporate Food Safety Director, Birdsong Peanuts, US
- Cynthia Donovan, retired associate professor, Agricultural Food and Resource Economics, Michigan State University, US
- Jeff Ehlers, program officer, Bill & Melinda Gates Foundation, US
- Andrew Emmott, independent consultant, UK
- Jeff Johnson, retired President, Birdsong Peanuts, US
- Isaac Minde, Deputy Director, Innovative Agricultural Research Initiative (iAGRI), Tanzania, and Professor of International Development, Michigan State University, US
- Shyam Nigam, expert consultant in agriculture for development, India
- Helga Recke, visiting fellow-CALS-AWARE, Cornell University, US
- Samara Sterling, Research Director, The Peanut Institute, US
- Farid Waliyar, independent consultant, retired from ICRISAT in 2014, France

The Peanut Innovation Lab Director and Assistant Director, and the USAID Agreement Officer's Representatives (Shivaun Leonard, Daniel Bailey) are *ex officio* members of the External Advisory Panel.

Program Countries

The Peanut Innovation Lab focus countries are Ghana, Malawi, Senegal and Uganda. Certain projects have research activities in India, Kenya, Mali and Niger.

Program Partners

United States of America

Institution	Department	City	State
International Food Policy Research Institute (IFPRI)		Washington	DC
Iowa State University		Ames	IA
North Carolina State University (NCSU)	Department of Crop and Soil Sciences	Raleigh	NC
	Department of Entomology and Plant Pathology	Raleigh	NC
The Ohio State University	Global Water Institute	Columbus	OH
	School of Environment and Natural Resources	Columbus	OH
Pennsylvania State University	College of Agricultural Sciences	University Park	PA
Stanford University	Center of Food Security and the Environment	Stanford	CA
Texas A&M University	Department of Soil and Crop Sciences	Lubbock	TX
Texas Tech University	Department of Plant and Soil Science	Lubbock	TX
United States Department of Agriculture-Agriculture Research Service (USDA-ARS)	Market Quality & Handling Research	Raleigh	NC
	National Peanut Research Laboratory (NPRL)	Dawson	GA
	Plant Genetic Resources Conservation Unit	Griffin	GA
University of California, Santa Barbara, (UCSB)	Department of Geography	Santa Barbara	CA
University of Florida	Institute of Food and Agricultural Sciences	Gainesville	FL
University of Georgia (UGA)	Department of Agricultural and Applied Economics	Athens	GA

Institution	Department	City	State
	Department of Crop and Soil Sciences	Athens	GA
	Department of Entomology	Athens	GA
	Department of Environmental Health Science	Athens	GA
	Department of Horticulture	Tifton	GA
	Department of Plant Pathology	Athens	GA
University of Tennessee	Institute of Agriculture	Knoxville	TN
Virginia Polytechnic Institute and State University	College of Agriculture & Life Sciences	Blacksburg	VA
	Tidewater Agricultural Research and Education Center	Suffolk	VA
Washington University, St. Louis	School of Medicine	St. Louis	MO

Foreign

Institution	Department	City
Ghana		
Council for Scientific and Industrial Research (CSIR)	Crop Research Institute (CRI)	Kumasi
	Savannah Agricultural Research Institute (SARI)	Nyankpala
Kwame Nkrumah University of Science and Technology (KNUST)		Kumasi
Project Peanut Butter		Kumasi
University for Development Studies (UDS)		Tamale
University of Ghana	School of Biological Science	Accra
India		
International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)		Patancheru
Kenya		
International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)		Nairobi
Malawi		
Department of Agricultural Research Services (DARS)	Chitedze Research Station	Chitedze
Horizon Farms		Lisungwe

Institution	Department	City
Lilongwe University of Agricultural and Natural Resources (LUANAR)	Crop and Soil Sciences Department	Bunda
	Department of Food Science and Technology	Bunda
	Food Technology and Nutrition Group	Lilongwe
Mexico		
Centro Internacional de Mejoramiento de Maíz y Trigo (CIMMYT)	Integrated Breeding Platform (IBP)	Mexico City
Mali		
Institut d'Economie Rurale (IER)	Centres Régionaux de Recherche Agronomique (CRRA)	Bamako
Mozambique		
Instituto de Investigação Agrária de Moçambique (IIAM)	Northeast Zonal Center	Nampula
Niger		
Centre Regional de la Recherche Agronomique du Niger (INRA)	Centre Régional de la Recherche Agronomique (CERRA)	Niamey
International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)	Sahelian Centre	Niamey
Senegal		
Centre de Recherche Pour le Developpement Économique et Social (CRDES)		Dakar
École Nationale Supérieure d'Agriculture de Thiès (ENSA)		Thiès
Institut Sénégalais de Reserches Agricoles (ISRA)	Centre d'Etude Régional pour l'Amélioration de l'Adaptation à la Sécheresse (CERAAS)	Thiès
	Centre National de Recherches Agronomiques (CNRA)	Bambey
Université Cheikh Anta Diop	Faculté des Sciences Économiques et de Gestion (FASEG)	Dakar
Université de Thiès		Thiès
Université Gaston Berger	L'Unité de Formation et de Recherche de Sciences Économiques et de Gestion	Saint-Louis
Uganda		
Makerere University	College of Agricultural and Environmental Sciences	Kampala
	Department of Disease Control and Environmental Health	Kampala
	School of Women and Gender Studies, Makerere University	Kampala
National Agricultural Research Organization (NARO)	National Crops Resources and Research Institute (NaCRRI)	Namulonge

Institution	Department	City
	National Semi Arid Resources Research Institute (NaSARRI)	Soroti
Zambia		
Zambia Agriculture Research Institute (ZARI)	Msekera Research Station	Chipata

Acronyms

AAGB	Advances in Arachis Genomics and Biotechnology
AB-QTL	advanced backcross-quantitative trait loci
ANCAR	Agence Nationale de Conseil Agricole et Rural, Senegal
AOR	Agreement Officer's Representative
APPSA	African Productivity Program for Southern Africa (World Bank)
ARS	Agricultural Research Service
BMS	Breeding Management System
CERAAS	Centre d'Etude Régional pour l'Amélioration de l'Adaptation á la Sécheresse, Senegal
CERDES	Centre de Recherche Pour le Developpement Economique et Social
CERRA	Centre Régional de la Recherche Agronomique, Niger
CIMMYT	Centro Internacional de Mejoramiento de Maíz y Trigo, Mexico
CIRAD	Centre de Coopération Internationale en Recherche Agronomique pour le Développement, France
CNRA	Centre National de Recherches Agronomiques, Senegal
Co-PI	co-principal investigator
CRI	Crops Research Institute, Ghana
CRRA	Centres Régionaux de Recherche Agronomique, Mali
CRSP	collaborative research support program
CSIR	Council for Scientific and Industrial Research, Ghana
CSSL	Chromosomal Segment Substitution Line
DARS	Department of Agricultural Research Services, Malawi
EAP	External Advisory Panel
EBCA	Enhancing Breeding Capacity in Africa
ENSA	École Nationale Supériere d'Agriculture
ESA	East and Southern Africa
FENAB	Fédération Nationale pour l'Agriculture Biologique, Senegal
FY19	Fiscal Year 2019
GGWG	Ghana Groundnut Working Group
GRD	Groundnut rosette disease
GREAT	Gender-responsive Researchers Equipped for Agricultural Transformation
GRV	groundnut rosette virus
GWAS	genome-wide associations study
GxE	genotype by environment
HTP	high-throughput phenotyping
IBP	Integrated Breeding Platform
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics, India
IER	Institut d'Economie Rurale, Mali
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute, USA
IIAM	Instituto de Investigação Agrária de Moçambique, Mozambique
INRA	Institut National de la Recherche Agronomique, Mali
INRAN	Institut National de la Recherche Agronomique du Niger
IRB	Institutional Review Board
ISRA	Institut Sénégalais de Researches Agricoles, Senegal
ITRA	Institut Togolais de Recherche Agronomique, Togo
IVSC	*in-vitro* seed colonization
KNUST	Kwame Nkrumah University of Science and Technology, Ghana
LLS	late leaf spot
LUANAR	Lilongwe University of Agricultural and Natural Resources, Malawi
ME	Management Entity
NaCRRI	National Crops Resources Research Institute, Uganda
NARO	National Agricultural Research Organization, Uganda
NARS	National Agricultural Research System
NaSARRI	National Semi-Arid Resources Research Institute, Uganda
NCSU	North Carolina State University, NC
NIFA	National Institute for Food and Agriculture, USA
NPRL	National Peanut Research Lab, GA
OSS	optimized shrub system
PI	principal investigator
PMIL	Peanut and Mycotoxin Innovation Lab
QDS	quality declared seed
QTL	quantitative trait loci
SARI	Savannah Agricultural Research Institute, Ghana
SNP	single-nucleotide polymorphism
SPAD	Soil-Plant Analysis Development
UGA	University of Georgia, GA
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
ZARI	Zambian Agricultural Research Institute, Zambia

Glossary

Abiotic stress: [ā-bī-ot'ik stres] negative impact to a plant by non-living sources, such as low or high temperature, deficient or excessive water, high salinity, heavy metals, and ultraviolet radiation. These hostile forces can impede plant growth and development, as well as yield loss.

Aflatoxin: [aflə'täksən] a class of toxic compounds that are produced by the fungi *Aspergillus flavus* and *A. parasiticus* after infecting various plant species, and can cause liver damage, cancer, stunting and even death in humans and other animals.

Anthropometric measurements: [an'thrō-pō-met'rik mĕzh´er-ments] a series of quantitative measurements of the muscle, bone, and adipose tissue used to assess the composition of the body. The core elements of anthropometry are height, weight, body mass index (BMI), body circumferences (waist, hip, and limbs), and skinfold thickness.

Aggregator: [ˈagrəˌgādər] an individual or business entity that collects and distributes product from multiple sources. Some examples of aggregators of farmers' produce: a farmers' market, a food hub, a distributor, or an individual farmer who does the product marketing for several other farmers.

Backcrossing: crossing of a hybrid with one of its parents or an individual genetically similar to its parent, in order to achieve offspring with a genetic identity which is closer to that of the parent.

Biotic stress: [bī-ot'ik stres] negative impact done to an organism by other living organisms, such as bacteria, viruses, fungi, parasites, beneficial and harmful insects, weeds, and cultivated or native plants.

Breeder seed: in peanut or groundnut, the nuts of plants grown by breeders to specifically increase the stock of a certain type of seed available in the future. (*See foundation seed*)

Colchicine: [kol´chĭ-sēn] a chemical that is often used to induce polyploidy in plants. Basically, colchicine prevents the microtubule formation during cell division, thus the chromosomes do not pull apart like they normally do.

Complex system: a group of entities that are inter-related, but whose behavior is intrinsically difficult to model due to the dependencies, competitions, relationships, or other types of interactions between their parts or between a given system and its environment.

Cross sectional survey: a study that collects data to make inferences about a population of interest at one point in time.

Early leaf spot (ELS): a major foliar disease caused by the fungus *Passalora arachidicola* that leads to circular brown spots with a yellow halo on the upper surface of the leaves and also on stems and pegs resulting in severe yield loss to the groundnut growers.

Foundation seed: in peanut, seed used by a commercial seed company to establish new production fields that will produce the seed for sale to farmers (*see breeder seed*).

Groundnut rosette virus: a pathogenic virus complex found in sub-Saharan Africa that is transmitted between plants by insect vectors such as the groundnut aphid (*Aphis craccivora*) and can cause significant yield loss.

Gut microbiome: the totality of microorganisms, bacteria, viruses, protozoa, and fungi, and their collective genetic material present in the gastrointestinal tract.

High-throughput phenotyping (HTP): the use of modern sensors, such as light- and color monitors, to record data on traits like plant development, architecture, plant photosynthesis, growth or biomass productivity to accelerate the in-field measurements of plant traits needed by plant breeders to determine which plant features and genomic characteristics are most critical to new plant development.

Inoculation: [ĭ-nok″u-la´shun] artificial exposure to an infectious disease. In peanut, inoculation may be used to artificially introduce a pathogen for testing resistance. Farmers may inoculate the soil by adding bacteria that infects the roots of the peanut plant and assists the plant's ability to fix nitrogen.

Introgression: [ĭn′trə-grĕsh′ən] in genetics, the movement of a gene from one species into the gene pool of another by the repeated backcrossing of an interspecific hybrid with one of its parent species.

Late leaf spot (LLS): a major foliar disease caused by the fungus *Nothopassalora personata* that leads to circular dark brown to black spots without a halo on the lower surface of the leaves and also on stems and pegs resulting in severe yield loss to the groundnut growers.

Marker assisted selection or marker aided selection (MAS): an indirect selection process where a trait of interest is selected based on a marker (morphological, biochemical or DNA/RNA variation) linked to a trait of interest (e.g. productivity, disease resistance, abiotic stress tolerance, and quality), rather than on the trait itself.

Metabolomics: [mə-tăb′ə-lŏm′ĭks] large-scale study of small molecules, commonly known as metabolites, within cells, biofluids, tissues or organisms. Collectively, these small molecules and their interactions within a biological system are known as the metabolome.

Metagenomics: [mĕt′ə-jə-nō′mĭks] the study of a collection of genetic material (genomes) from a mixed community of organisms. Metagenomics usually refers to the study of microbial communities.

Mycotoxin: [mī′kō-tŏk′sĭn] a toxic secondary metabolite produced by organisms of the fungus kingdom that is capable of causing disease and death in both humans and other animals.

Nematodes: [nem-uh-tohd] multicellular insects that live in soil and feed on plant roots.

Normalized digital vegetative index (NDVI): A value that quantifies vegetation by measuring the difference between near-infrared (which vegetation strongly reflects) and red light (which vegetation absorbs).

Oleic acid: [ō-lē'ik as'id] a monounsaturated fatty acid with good resistance to rancidity which may reduce the risk of coronary heart disease when substituted for saturated fats in cooking.

Organoleptic characteristics: [ōr'gă-nō-lep'tik kar-ik-tuh'ris-tiks] the aspects of food, water or other substances that create an individual experience via the senses – including taste, sight, smell, and touch.

Polymorphism: a discontinuous genetic variation resulting in the occurrence of several different forms or types of individuals among the members of a single species.

Polyploid: [pälē' ploid] a cell or nucleus that contains more than two homologous sets of chromosomes.

Quantitative trait locus (QTL): a region of DNA which is associated with a particular phenotypic trait, which varies in degree and which can be attributed to polygenic effects, i.e., the product of two or more genes, and their environment.

Recombinant inbred line (RIL): [rē-kŏm′bə-nənt ĭn′brĕd′ līn] a recombinant inbred strain (or recombinant inbred line) is an organism with chromosomes that incorporate an essentially permanent set of recombination events between chromosomes inherited from two or more parental lines.

Resilience: [rĭ-zĭl′yəns] the ability to absorb and recover from shocks and stresses. In plants, these stresses or shocks may be related to drought or disease.

Reticulation: (rĭ-tĭk′yə-lā'shun] a pattern or arrangement of interlacing lines resembling a net.

Standardized precipitation index: a widely used index to characterize meteorological drought on a range of timescales.

Tomato spotted wilt virus: an important disease of many different crops grown in temperate and subtropical regions of the world. A unique virus in a virus class by itself, TSWV can infect more than 1,000 species in 85 families.

Weather shocks: temperature deviations from the long-run normal values which may lead to drought, flooding, storms or other negative weather events.

Executive Summary

Despite the COVID-19 pandemic, all projects achieved significant advances during FY2020. Following meetings the previous year to launch projects in Ghana and Uganda, a final project-launching meeting was accomplished in October 2019 in Senegal. Prior to the meeting, several ME staff, PIs and local scientists visited sites in Thiès, Bambey and Nioro, viewed long-term trials with *Piliostigma* and *Guiera* in the Optimized Shrub System project near Thiès, and saw fields recently planted with the core collection of 300 peanut lines.

All gender and youth project PIs, the ME and EAP advisor Helga Recke came together for a workshop at UGA in December 2019, while students and co-PIs from all research areas in Eastern Africa met in Kampala, Uganda in March 2020 for a training session on gender in agricultural research led by GREAT. That group spent three days learning and discussing how best to incorporate gender considerations into their research projects. Given the success of the workshop, additional workshops are planned for Senegal and Ghana in 2021.

Breeders in Senegal and Uganda produced seed of the 300 core lines identified from the diversity analysis of 1200 African lines and sent the seed to breeders in Mali, Ghana, Malawi, Mozambique and Zambia to phenotype next season. Three national programs received phenotyping tools and training in how to apply the tools to peanut. In Ghana, Uganda and Senegal, graduate students are using some of these tools in their research projects, providing valuable information on how they function in African field conditions in order to improve how the tools are used in other countries.

Nutrition projects are close to starting in-country activities, but were put on hold due to COVID-19. A school feeding project in Ghana developed four peanut-based school foods, received FDA approval for testing and plans acceptance trials as soon as COVID-19 restrictions allow. A study on the effects of peanut consumption on the gut microbiome received IRB approvals, identified schools willing to participate, and determined where to purchase the required peanut packages to deliver to Uganda. The trials were set to start in late May but are delayed due to the pandemic.

Projects focused on gender and youth in Ghana are moving forward. A study of gendered time poverty switching to phone interviews and successfully completed a first round of surveys. A project looking at incentives for farmers to produce and sell quality peanuts hit a setback when local buyers did not commit to purchase peanuts as planned; researchers have identified an alternative buyer in the Tumu area who is excited about working with the project. The project will pilot the purchasing of local groundnuts in October/November 2020. Project Peanut Butter in Kumasi, Ghana has agreed to purchase the groundnuts for use in producing RUTF and other peanut-based products.

The youth empowerment project in Uganda completed a first workshop to identify the villages where the study will take place and conducted initial interviews with prospective youth in each village. For a time-use project in Senegal, researchers designed and tested a prototype device in California that will capture time and activity data among peanut farmers; researchers also conducted initial rapid ethnographic assessments in the Kaolack region of Senegal prior to the COVID-related closures. Likewise, the baseline survey for the Senegal youth engagement and land tenure project was also able to complete their large survey only a week prior to the closures.

Focus Country Key Accomplishments

Ghana

The Peanut Innovation Lab has five projects specifically working in Ghana including all four Areas of Inquiry (Variety Development, Value-Added Gains, Nutrition and Gender & Youth), as well as regional and continent-wide projects with activities in Ghana. Eleven graduate students (3 female, 8 male) supported by the project are from Ghana.

As part of the coordinated pan-African effort, CSIR-SARI is evaluating lines for pest and disease resistance, tolerance to water-stress, days to maturity, harvest index and yield in replicated field trials near Tamale. A project is evaluating high-throughput phenotyping tools to assist in the trials. Lines that show advantageous traits will be crossed to local varieties and advanced to large-scale field trials. Plans are underway to provide the CSIR-SARI and CSIR-CRI groundnut breeding programs a groundnut sheller/aspirator and grading table developed by Frank's Design for Peanuts with the Peanut Innovation Lab to speed up seed processing.

Key accomplishments from FY2020 include:

- Three peanut-based food products were developed for school-feeding trials with NGO partner, Project Peanut Butter. Trials will be conducted in the Feed the Future target zone when schools reopen.
- 2nd Annual Ghana Groundnut Working Group meeting in Tamale was held in March. The group is connecting local researchers with farmers, aggregators, processors, NGOs and others to better align research objectives, share findings and create a better network focused on the groundnut value chain.
- A village-based ethnographic study in the Feed the Future target zone was converted to a phone-based household survey due to COVID restrictions. The survey specifically inquired about gender and time allocations for groundnut production. These findings will inform future interventions to reduce women's time poverty.
- A seed survey was completed by Borlaug MS student at KNUST. Seed was obtained from farmers, seed sellers, markets and research partners in three regions to assess quality, germination, purity and background information on the seed system, a constraint to scaling improved varieties.
- A public-private research partnership has been formed linking Project Peanut Butter and a scaled aggregator in Tumu working with women farmers to test price premiums for on-farm aflatoxin-control measures.

Malawi

The Peanut Innovation Lab has two projects in Malawi focused on remote sensing and evaluating input packages for groundnut farmers. These projects are closely aligned with the local USAID Mission-funded Agriculture Diversification Activity (AgDiv), providing technical support to partners and building linkages between the private sector, LUANAR and DARS.

There is one graduate student (male) directly supported by the project and two graduate students (1 female, 1 male) supported in collaboration with AgDiv.

As part of the coordinated pan-African effort, DARS is evaluating lines for pest and disease resistance, tolerance to drought-stress, days to maturity, harvest index and yield in replicated field trials. Well-performing lines will be crossed to local varieties and advanced to large-scale field trials.

Key Accomplishments in FY2020 include:

- Three improved groundnut varieties were released by DARS. Two varieties were started under other grants, while the third fills a demand in the private-sector and gained approval through data collected in an Innovation Lab-linked partnership with ZARI in Zambia.
- Novel equipment was developed in partnership with a private manufacturer in the US for a "buying point in a box" approach that allows buyers to select for quality when purchasing and, therefore, reduce aflatoxin risk. The motorized sheller, aspirator, and sizing equipment were paired with moisture meter and mobile quantitative aflatoxin testing.
- Extensive qualitative fieldwork was completed as a follow up to an AgDiv-sponsored survey. The targeted findings included challenges to timely planting and gender-focused time constraints determined in the survey. Additional econometric analysis was also completed on the survey data to look closer at gender related issues.

Senegal

The Peanut Innovation Lab also has five specific projects working in Senegal including three Areas of Inquiry (Variety Development, Value-Added Gains and Gender & Youth). The lab is supporting 16 graduate students (7 female, 9 male).

Researchers at CERAAS are leading the West African component of a continent-wide genetic diversity study that links NARS to evaluate lines for pest and disease resistance, tolerance to drought-stress, days to maturity, harvest index and yield in replicated field trials. Well-performing lines will be crossed to local varieties and advanced to large-scale field trials. Two additional projects involve the use of cutting-edge genomic technology to develop genetic markers and introduces alleles from the wild relatives of peanuts that will improve the genetic diversity of cultivated peanut and offer new mechanisms for disease resistance, drought tolerance and other traits. A separate project in Senegal, Uganda and Ghana is evaluating low-cost high-throughput phenotyping technologies to assist in all field trials.

Key Accomplishments in FY2020 include:

- Completion of a rapid ethnographic survey in the peanut basin, exploring how a person's gender relates to roles in peanut production and time poverty. A related pilot study was also initiated in California to test a novel wrist device system for time and effort tracking, which will be launched in Senegal as soon as completed.
- Completion of a large (n=1223) household survey in the peanut basin targeting information on youth participation and particularly related to land tenure and climate variability. Field plots (n=2590) were taken with GPS to be assessed by remote sensing. This was completed just prior to the COVID closures.
- A project to evaluate the genetic diversity of peanut has now grown a core set of 300 lines twice in the country, allowing researchers across the region to share the seed, grow out the lines and further evaluate them. This collection was also used to replace germplasm lost due to a power outage in Togo.

Uganda

The Peanut Innovation Lab also has six projects specifically working in Uganda, including all four Areas of Inquiry (Variety Development, Value-Added Gains, Nutrition and Gender & Youth). The lab is supporting 6 graduate students (4 female, 2 male) in the country.

Researchers at NARO are leading the East African component of a continent-wide genetic diversity study that links NARS to evaluate lines for pest and disease resistance, tolerance to drought-stress, days to maturity, harvest index and yield in replicated field trials. Well performing lines will be crossed to local varieties and advanced to large-scale field trials. Two additional projects involve the use of cutting-edge genomic technology for marker development and introduction of alleles from the wild relatives of peanuts that will improve the genetic diversity of cultivated peanut with the potential to offer new mechanisms for disease resistance, drought tolerance and other traits. A separate project in Senegal, Uganda and Ghana is evaluating low-cost high-throughput phenotyping technologies to assist in all field trials.

Key Accomplishments in FY2020 include:

- The lab helped to organize a first-of-its-kind gender sensitization training with the GREAT team at Makerere University, bringing collaborators, including students, from across the region to better develop their research perspectives concerning gender in the peanut value chain.
- A project completed an initial survey of potential alternative hosts for the viruses that cause the devastating groundnut rosette disease, a scourge across the continent. If confirmed, this may offer additional IPM strategies to control the disease.
- NARO has completed the multiplication of 300 core varieties from the Africa-wide collection, including evaluation using novel digital phenotyping tools, and has made pure seed available to regional partners.

Research Program Overview and Structure

The Peanut Innovation Lab contributes to the Global Food Security Strategy by increasing the production, sustainability, profitability and use of peanut in targeted developing countries and the US. This is achieved through research linkages between US and developing country scientists in four Areas of Inquiry: 1) improved peanut varieties, 2) increased value-added gains along the peanut value chain, 3) increased understanding of the value of peanut consumption in human nutrition, and 4) increased understanding of gender and youth dimensions along the peanut value chain.

Area of Inquiry 1 (Improved Varieties) builds partnerships between peanut breeding programs in the US and target countries to use modern genomic and information technologies in the breeding programs. The objective is to enhance the capacity of peanut breeding programs in each country to develop new varieties using modern approaches, and to test and release varieties that increase yields and address the local, national and regional demands of the country.

Area of Inquiry 2 (Value-Added Gains) builds partnerships between the public and private sector and establishes new partnerships in seed production and local processing. Research focuses on seed production of improved varieties, best management practices to optimize quantity and quality of the crop by smallholder farmers, and effective practices for harvesting, drying, storage and shelling.

Area of Inquiry 3 (Nutrition) uses linkages with the US Peanut Institute to assess the benefits of peanut-based foods for school feeding programs and impacts of peanut consumption on human microbiota.

Area of Inquiry 4 (Gender and Youth) seeks to improve our understanding of the roles that gender and youth play in mediating interactions with peanut value chains in each target country. Research and training efforts also focus on improving the gender-sensitivity and responsiveness of Peanut Innovation Lab scientists, students, partners and programs.

Theory of Change and Impact Pathways

The main objective of the Peanut Innovation Lab is to support research that leads to the increased production, sustainability and profitability of peanuts in targeted developing countries. This objective is met through joint research and capacity building between US and developing country partners. Ultimately, the results are a part of the US government goals as defined under the Global Food Security Strategy.

Significant outputs from the Peanut Innovation Lab research include:

- molecular markers for drought and disease resistance,
- novel germplasm that contains genetic materials from wild relatives,
- phenotyping tools to more rapidly identify the best varieties under field conditions,
- improved varieties with enhanced productivity and nutritional traits, and
- new agronomical practices that combine inputs such as inoculants, fertilizers, and weed/pest/disease management.

These outputs are developed in collaboration with the intended users (national program scientists), increasing the chance they will be adopted rapidly. The Peanut Innovation Lab is training researchers in partner countries to use molecular technologies and providing guidance in crossing new germplasm, application of phenotyping tools, and appropriate use of agronomic packages. The Innovation Lab also invests in building capacity within partner countries by supplying most of the technologies (e.g., phenotyping tools) as part of the research project. Through the uptake of the new technologies, researchers will be able to develop improved varieties that allow farmers to meet market opportunities and deal with unpredictable environmental stresses. As farmers adopt new varieties, they will experience larger and more reliable yields. Increased production makes more food available for consumption in the household and for sale in local markets, creating income to meet other household needs.

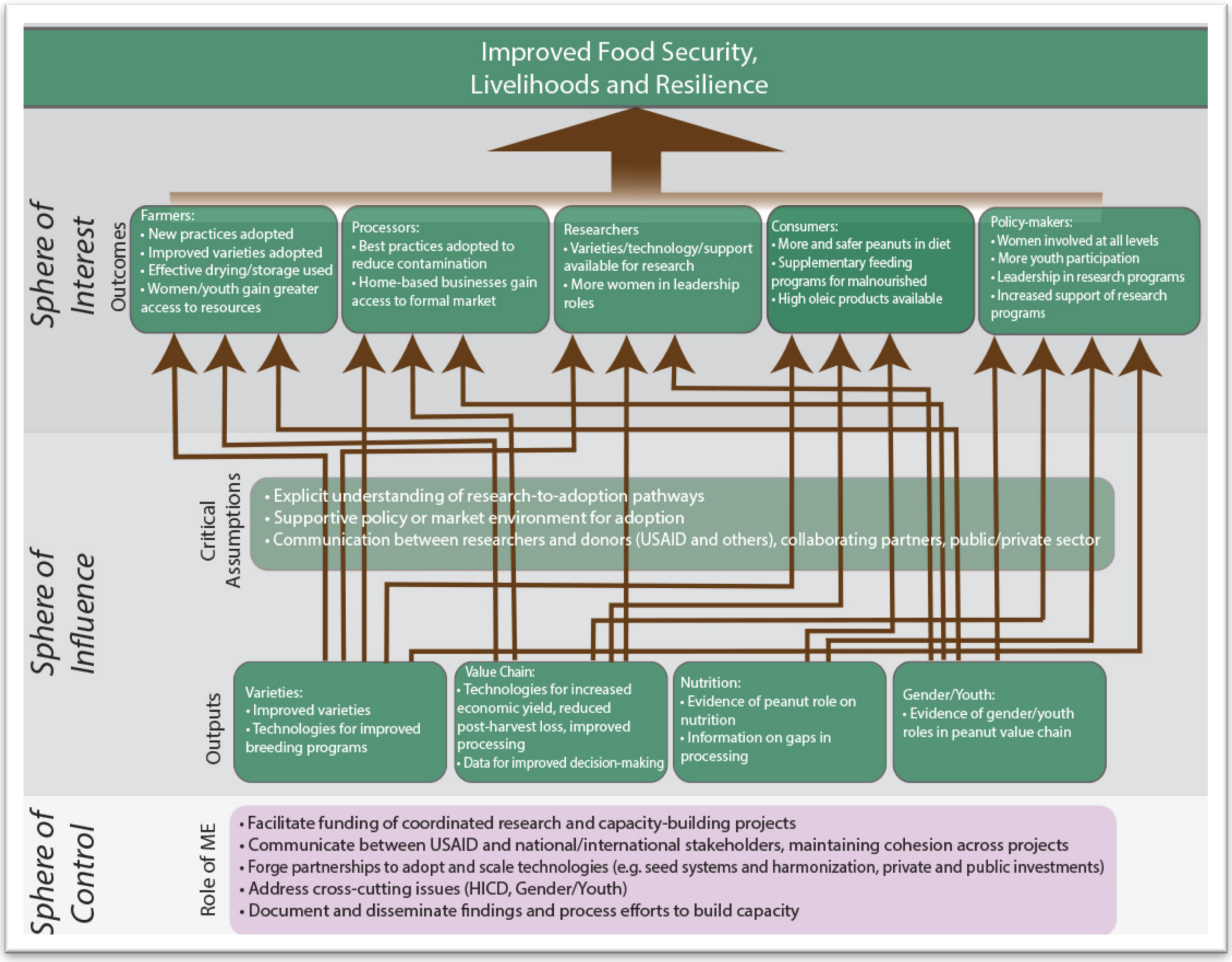
A major assumption is that government support for groundnut production and consumption continues and even increases. Government stability will also be important to maintain market opportunities and government funding.

Other outputs from the Peanut Innovation Lab research include appropriately scaled mechanization for shelling and grading groundnuts, an output that will be delivered to potential users, such as national programs and the private sector. Mechanization is seen as an important step in improving the production and profitability of peanut and as the uptake of appropriate technology happens, production of quality peanuts will grow. This will lead to more opportunities to reach markets (in-country, regional and global), increasing the economic returns for all value-chain actors.

Another output – new peanut-based school foods – will be distributed in public and private schools. Training in how to manufacture and process these foods will foster local entrepreneurs, leading to opportunities for in-country production and marketing.

Finally, research on the effects of peanut consumption on cognitive learning and gut health and on gender and youth involvement along the peanut value chain will bring in new knowledge that our research partners can use to address key constraints in peanut value chain, improving overall production and the inclusivity of related interventions. Knowledge will be disseminated to

stakeholders via Peanut Innovation Lab and other project workshops, policy reports, etc. Key information could lead to policies favorable to peanut production, use and consumption, including gender equality and addressing youth issues.



A. Varietal Development Research Project Reports

Project A1. Adoption of the Breeding Management System (BMS) by national programs [COMPLETED]

Research Locations

NARO-NaSARRI, Soroti, Uganda; DARS-Chitedze Research Station, Chitedze, Malawi; ZARI, Chipata, Zambia; IIAM, Nampula, Mozambique

Description

This completed project, commissioned in early 2018 for one year, improved the efficiency of plant breeding programs in target countries by enabling plant breeders to access a modern analytical pipeline, breeding technologies/materials and related information in a centralized, integrated and practical manner, and to deliver improved varieties that meet local farmers' needs and market demand.

Specifically, the project provided the necessary hardware and software for breeding programs in three countries (Malawi, Mozambique and Zambia) that are part of the peanut breeding network in Africa but have not been able to adopt the tools due to a lack of resources. The project is jointly implemented with the Integrated Breeding Platform (IBP) and involves the deployment and use of the Breeding Management System (BMS) developed by the IBP.

Theory of Change/Impact Pathway(s)

Use of digital informatics software will lead to more efficient and effective breeding programs, resulting in better varieties in less time. These varieties can then reach farmers faster, giving them higher yields that improve their household food security.

Collaborators

David Okello Kalule (PI), NARO-NaSARRI, Uganda; Justus Chintu, DARS, Malawi; Lutangu Makweti, ZARI, Zambia; Amade Muitia, IIAM, Mozambique; Graham McLaren, IBP, Mexico.

Project A2. Assessment of breeding program needs and seed production [COMPLETED]

Research Locations

NARO-NaSARRI, Soroti, Uganda; DARS-Chitedze Research Station, Lilongwe, Malawi; ZARI, Chipata, Zambia; IIAM, Nampula, Mozambique; CSIR-CRI, Kumasi, Ghana; CSIR-SARI, Tamale, Ghana; ISRA-CERAAS, Thiès, Senegal

Description

This second completed commissioned one-year project produced breeder and foundation seed of improved varieties, assessed and prioritized national peanut breeding program needs in the target countries for effective participation in future Peanut Innovation Lab projects.

Theory of Change/Impact Pathway(s)

Addressing the key constraints in breeding programs will lead to more efficient and effective programs, resulting in better varieties in less time. Improving the production of early generation seed (which is used by breeders or commercial seed producers) makes it easier to produce quality certified seed for farmers. When farmers have quicker access to higher quality varieties, they experience higher yields that improve household food security.

Collaborators

David Okello Kalule (PI), NARO-NaSARRI, Uganda; James Asibou, CSIR-CRI & Richard Oteng Frimpong, CSIR-SARI, Ghana; Justus Chintu, DARS, Malawi; Issa Faye, ISRA & Daniel Fonceka, CERAAS, Senegal; Lutangu Makweti, ZARI, Zambia; Amade Muitia, IIAM, Mozambique

Project A3. SNP genotyping of African peanut germplasm [COMPLETED]

Research Locations

ISRA-CERAAS, Thiès, Senegal; University of Georgia, Tifton, GA, USA

Description

The project, commissioned at the beginning of the Peanut Innovation Lab, is genotyping a wide array of African peanut germplasm using the high-density, 48K Axiom_Arachis2 SNP array. The SNP array, recently created by a project led by the PI, allows the efficient detection of 30,539 SNPs (single nucleotide polymorphisms) in the peanut genome at a reasonable price per line. The array already has been used to genotype several peanut populations segregating for resistance to nematodes, tomato spotted wilt virus, late leaf spot, and white mold, and for several seed traits, as well as a set of lines used to screen for low aflatoxin contamination.

Genotyping diverse germplasm relevant to the Peanut Innovation Lab allows breeders to take advantage of the latest genetic technologies in peanut to catalog genetic diversity among varieties, identify regions of the genome that hold positive or negative traits or alleles fixed in a breeding program, enable genome-wide background selection, identify a subset of polymorphisms to be developed for single-marker analysis for specific traits, and construct genetic maps of populations segregating for important traits.

Applying genomic information in peanut breeding will accelerate the incorporation of alleles for biotic and abiotic stress tolerance and seed quality traits resulting in a healthier and higher value crop.

Theory of Change/Impact Pathway(s)

Information on the genetic makeup of varieties allows breeders to broaden the diversity in their programs. This results in more resilient varieties delivered to farmers, increased yields, and ultimately improved household food security.

Collaborators

Peggy Ozias-Akins (PI), UGA, GA; Daniel Fonceka, ISRA-CERAAS & Issa Faye, ISRA, Senegal; David Okello Kalule, NARO-NaSARRI, Uganda; James Asibuo & Richard Oteng Frimpong, CSIR-CRI, Ghana; Amade Muitia, IIAM, Mozambique; Justus Chintu, DARS,

Malawi; Lutangu Makweti, ZARI, Zambia; Dramane Sako CRRA/IER, Mal; Adama Coulibaly, INRAN, Niger; Essohouna Banla, Togo

Achievements

SNP genotyping of all materials has been completed, a set of 300 lines identified representing the diversity of the entire set, and seed is being increased for distribution to all breeders under separately funded projects (see Projects A6 and A7). The selected set of 300 lines was re-genotyped with the SNP chip to ensure that the lines being distributed to the breeding programs for phenotyping have remained uniform. Once the genotypic data are available for the re-genotyped set and US materials of African origin (see Project A4), comprehensive data analysis will be conducted and shared with the breeders.

Capacity Building

The project continues to interact closely with CERAAS and other African scientists and students.

Lessons Learned

Generating sufficient quantities of seed for a collective study is challenging with peanut, especially when providing seed to match the planting windows of the geographically diverse programs.

Presentations and Publications

None to report in this period.

Project A4. Leveraging genetic resources to enhance peanut breeding in Africa and the US

Research Locations

NARO-NaSARRI, Soroti, Uganda; ISRA-CERAAS, Thiès, Senegal; University of Georgia, Tifton, GA, USA

Description

The objective of this project is to genotype more than 2650 accessions of African origin conserved in the USDA peanut germplasm collection, then to combine data with the genotypes generated from African breeding materials under Project A3. The project is jointly funded with the Peanut Research Foundation, a US peanut industry supported foundation. Through a USDA NIFA-sponsored project, 276 African accessions also are being genotyped.

Relatedness of these 2900+ lines to each other and to those in current African breeding programs will be determined from the genotypes, allowing breeders to make informed decisions on how to increase diversity in their programs.

Theory of Change/Impact Pathway(s)

Information on the genetic makeup of varieties allows breeders a more diverse base of traits to use in their programs. This results in more resilient varieties delivered to farmers, increased yields, and ultimately improved household food security.

Collaborators

Peggy Ozias-Akins (PI), UGA, Tifton, GA; Corley Holbrook, USDA-ARS, Tifton, GA; Shyam Tallury, Plant Genetic Resources Conservation Unit, Griffin, GA; Josh Clevenger, HudsonAlpha Institute of Biotechnology, Huntsville, AL; Ye Chu, UGA, Tifton, GA, ; Jean-Marcel Ribaut, Integrated Breeding Platform, CIMMYT, El Batán Texcoco, Mexico; Ethalinda Cannon, Iowa State University, Ames, IA; Jean-Francois Rami, CIRAD, Montpellier, France; Daniel Fonceka, CERAAS, Senegal; David Okello Kalule, NARO-NaSARRI, Uganda

Achievements

A total of 2658 accessions were planted in the greenhouse in Tifton, GA. For the 2486 accessions that germinated, single plants were sampled, DNA extracted and sent for SNP genotyping using the 48K Affymetrix SNP chip. Seed was produced from all sampled lines for future use and distribution. All genotype data has been received. Preliminary analysis indicated that the US accessions contained some clusters that are isolated from the African lines previously genotyped under Project A3. This preliminary analysis supports our hypothesis that the US collection may contain unique variation of interest to the African breeders. Further analysis is underway. The genotypic data will be submitted to PeanutBase, the open source repository of peanut genetic information, once it is fully cleaned.

Capacity Building

The project is an excellent collaboration between the USDA germplasm curator (Shyam Tallury), USDA peanut breeder (Corley Holbrook), ISRA-CERAAS / CIRAD scientist (Daniel Fonceka) and UGA geneticist (Peggy Ozias-Akins).

Lessons Learned

Although anticipated, space for the cultivation of the large number of accessions was limited. The project was able to obtain additional greenhouse space from USDA. There were some delays due to COVID-19 restrictions but the work was completed.

Presentations and Publications

Ozias-Akins, P. 2020. Leveraging genetic resources to enhance peanut breeding in Africa and the US. Presentation at the Peanut Innovation Lab Annual Research Meeting, 2-4 June 2020 (Virtual).

Ozias-Akins, P., Chu, Y., Clevenger, J., Rami, J., Tallury, S., Kalule, D. O. & Fonceka, D. 2019. Genetic diversity of historical and contemporary African germplasm lines. Presentation at the AAGB Conference, Jinan, China

Project A5. Integration of high throughput phenotyping (HTP) for enhancing breeding programs

Research Locations

NARO-NaSARRI, Soroti, Uganda; CSIR-SARI, Kumasi, Ghana; KNUST, Kumasi, Ghana; CSIR-SARI, Tamale, Ghana; ISRA-CERAAS, Thiès, Senegal; ISRA-CNRA, Bambey, Senegal

Description

Peanut yield and quality are low in much of Africa. With basic agricultural inputs unavailable, soils depleted of phosphorus and other essential plant nutrients, scarce precipitation, and high disease pressure, peanut production can be improved through the development of new cultivars with more efficient use of water and nutrients, and disease resistance. Breeding efforts can

benefit from the development of high throughput phenotyping tools using new, yet inexpensive, technologies and sensors.

The project objectives include: 1) developing high-throughput phenotyping (HTP) tools for field selection for disease, drought, and variety performance; 2) developing effective HTP systems to determine peanut maturity and oleic fatty acid content – necessary steps towards quality control in seed production; 3) enhancing the breeding capabilities in Africa by procuring relatively inexpensive sensors and the software needed to retrieve data, as well as training researchers in how to use the tools; and 4) improving youth and gender awareness about innovative plant breeding and variety development by collaborating with 4-H youth clubs in Senegal and Ghana and the Youth Farmers Association of Uganda.

Theory of Change/Impact Pathway(s)

The ability to determine the performance characteristics for large number of lines allows breeders to select the best individual ones. Phenotyping tools used in this project will allow breeding programs to utilize the tools in their research. This results in more resilient varieties delivered to farmers, increased yields, and ultimately improved household food security.

Collaborators

Maria Balota (PI), Virginia Tech, VA; David Okello Kalule, NARO-NaSARRI, Uganda; Richard Oteng-Frimpong, CSIR-SARI, Ghana; Richard Akromah, KNUST, Ghana; Daniel Fonceka, ISRA-CERAAS and Issa Faye, ISRA-CNRA, Senegal

Achievements

The phenotyping equipment including SPAD chlorophyll meter, GreenSeeker NDVI, chlorophyll fluorometer, thermal camera, RGB camera and MultiSpeQ PhotoSynQ device were purchased and delivered to CSIR-SARI in Ghana, ISRA/CERAAS in Senegal and NARO-NaSARRI in Uganda.

In Ghana, 192 genotypes were phenotyped for maturity, plant height, leaf spot and plant vigor using the HTP tools. Correlation analysis is underway.

In Uganda, an MSc student evaluated 250 genotypes at two locations using the HTP tools. Trait data collected included plant vigor, leaf spot and rosette ratings, and yield. Multiple readings were made with each HTP tool and correlations with the phenotypic data is underway. Preliminary results indicate that some of the HTP tools are well correlated with late leafspot, GRD and plant vigor.

In Senegal, 21 genotypes are being evaluated for morphological traits in two locations using the HTP tools. Trials are being conducted under both well-watered and drought conditions to specifically determine which tool may be best for identifying drought tolerance in peanut.

A graduate student measures fluorescence with chlorophyll fluorometer at a training session in Uganda in early 2020.

Capacity Building

Phenotyping equipment was purchased and delivered to each national program. Master's students (one in Ghana, two in Senegal and one in Uganda) were recruited and are either completing coursework or undertaking field work as part of their degree training. The PI conducted a HTP tools training workshop for SARI scientists, students and technician at CSIR-SARI in Tamale, for NARO scientists, staff and students in Uganda, and at CERAAS/ISRA in Thiès to learn.

Lessons Learned

Designing and conducting large-scale phenotyping trials requires the entire team. It is important to consider the time required to acquire data from the field trials and plan accordingly (e.g., provide required transport to/from fields). Data storage for digital images is critical and may require large-capacity storage devices. Climate variability can interfere with trials, especially proposed evaluations under drought conditions. This will require repeat trials at other locations or years, and/or trials conducted in rainout shelters or greenhouses.

Presentations and Publications

Balota, M. 2020. Integration of high throughput phenotyping (HTP) for enhancing breeding programs in Ghana, Senegal and Uganda. Presentation at the Peanut Innovation Lab Annual Research Meeting, 2-4 June 2020 (Virtual).

Chapu, I., Ongom, C., Kalule, D. O. & Balota, M. 2020. High-throughput phenotyping for disease and drought stress selection in groundnut (Arachis hypogaea L. Presentation at the 52nd American Peanut Research and Education Society Conference (Virtual).

Kalule, D. O., Chapu, I., Ugen, M., Okori, P. & Desmae, H. 2020. Breeding for extra early and early drought tolerant groundnuts in Uganda. Presentation at InterDrought Conference, Mexico City, Mexico.

Sie, E.K., Oteng-Frinpong, R., Danquah, A., Balota, M., Hoisington, D. & Rhoads, J. 2020. Field phenotyping of biotic and abiotic stress in peanut for increased genetic gains in Ghana. Presentation at the 52nd American Peanut Research and Education Society Conference (Virtual).

Project A6. Enhancing the genetic potential of peanut production in Eastern and Southern Africa

Research Locations

NARO-NaSARRI, Soroti, Uganda; DARS-Chitedze Research Station, Chitedze, Malawi; ZARI, Chipata, Zambia; IIAM, Nampula, Mozambique; ISRA-CERAAS, Thiès, Senegal

Description

The use of molecular markers to identify diverse genetic traits and improve crops is a proven and successful approach. Following a drastic reduction in genotyping costs and increased analytical power over the last decade, genome-wide association studies (GWAS) are a powerful way to dissect target traits and identify favorable alleles/genomic regions that are responsible for the trait. In peanut, genetic variations have mainly been identified and exploited, until now, by breeders using bi-parental populations because of the lack of polymorphism in the cultivated species, and of suitable and cost-effective genotyping technologies. Recent advances in peanut genomics – including the sequencing of cultivated peanut and the development of a high-density genotyping Axiom_Arachis array with thousands of polymorphic SNP for cultivated peanut – open the way for high-throughput genotyping in peanut, allowing effective genetic dissection of target traits and the identification of major genes and/or QTLs for marker-assisted breeding.

Accessions identified through another project (A3) will be tested in diverse environments and conditions in at least four countries in Eastern and Southern Africa through this project and four in West Africa through Daniel Fonceka's project to generate relevant information and data around diversity and the genetic basis for target traits, empowering peanut breeding programs, and the development of new genes/markers for molecular breeding. The overall objective of the project is to characterize and document a unique pool of material that can be used as a new source of germplasm and alleles to improve peanut breeding in Eastern and Southern Africa.

This coordinated effort across strong, existing networks will enable us to: 1) assess diversity and identify germplasm from the core panel to be introduced to national breeding programs to fill possible diversity gaps; 2) dissect the genetic control of target trait variation via association studies, and identify trait-linked markers for breeding purposes; 3) based on performance, identify potential new donor lines for local breeding programs; and 4) increase capacities for a vibrant network of peanut breeders in Eastern and Southern Africa to apply modern genetic approaches in breeding, and to collectively share and analyze data.

Theory of Change/Impact Pathway(s)

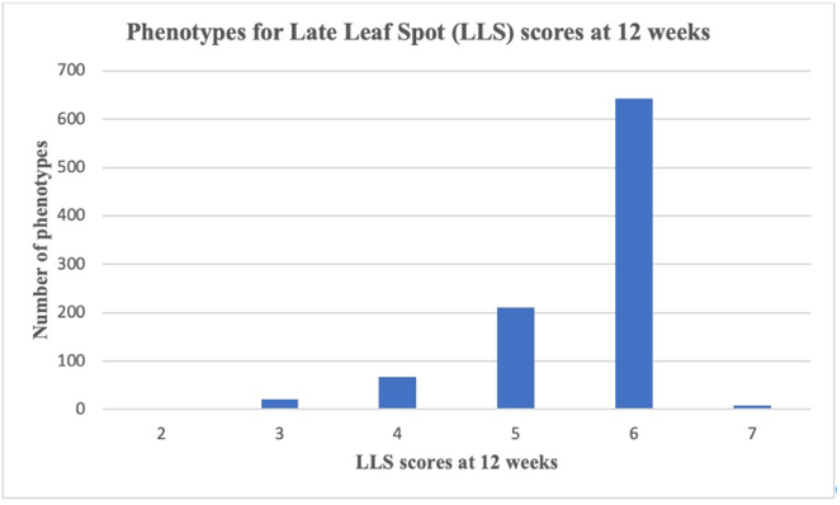
Information on the genetic makeup of varieties and use of core sets based on this information allows breeders to broaden the diversity in their programs. This results in more resilient varieties delivered to farmers, increased yields, and ultimately improved household food security.

Collaborators

David Okello Kalule (PI), NARO- NaSARRI, Uganda; Lutangu Makweti, ZARI, Zambia; Amade Muitia, IIAM, Mozambique; Justus Chintu, DARS, Malawi**;** Jean-Marcel Ribaut, IBP, Mexico**;** Peggy Ozias-Akins, UGA, GA**;** Daniel Fonceka, ISRA-CERAAS, Senegal

Achievements

A seed multiplication trial of 980 lines from the African diversity collection was conducted at NaSARRI-Serere. Seed of the core 300 lines was scheduled to be sent to the NARS partners in Malawi, Mozambique and Zambia in October 2020, and used for phenotyping trials in Uganda next season. Seed of all 980 lines will be available to all breeders upon request.



Late leaf spot trials are conducted on the African diversity collection at Serere, Uganda in 2019/20.

Due to high leaf spot disease pressure this cycle in Uganda, the lines were evaluated for resistance. Out of the 980 lines, 22 lines were scored as resistant with a disease rating of less than 3 (1-9 scale). Further trials will be conducted to identify the most resistant materials.

Capacity Building

The project is partnering with the IFAD-funded EBCA project led by the Integrated Breeding Platform (IBP) to establish additional breeding expertise. Team staff participated in gender training workshop conducted by the Peanut Innovation Lab and GREAT team at Makerere University.

The project PI trained local Ugandan seed business groups in the production of quality declared groundnut seed in February 2020.

A PhD student stands in trial plots conducted on the African diversity collection at Serere, Uganda in 2019/20.

The PhD student completed her coursework and successfully defended her thesis proposal in March 2020. She participated in the African Plant Breeders Association conference in Accra, Ghana in October 2019 and made a presentation on the groundnut program at NaSARRI and her proposed thesis work. She also participated in the ACE-II CESAAM summer school on agricultural transformation for sustainable development in Africa in November 2019 at Egerton University, Kenya.

Thirty-three professionals and students trained in the BMS in a two-day workshop at NaSARRI in February 2020.

Lessons Learned

Given the importance and size of the trials, supplemental irrigation needs to be available especially with recent unpredictability of rain. In addition, threats of locust and leafminer attacks need to be planned for and contingency plans put into place.

Presentations and Publications

Chemutai, R. M., P., Mwololo, J. & Kalule, D. O. 2020. Genetics of Nutrient Dense Groundnuts lines for Yield and Resistance to major foliar diseases in Uganda and Malawi. Presentation at the Peanut Innovation Lab Graduate Student Conference (Virtual).

Lomotey, T., Mwololo, J., Odong, T., & Kalule, D. O. 2020. Genetic Studies in Groundnut for Resistance to Rust Disease. Presentation at the Peanut Innovation Lab Graduate Student Conference (Virtual).

Okaron, V. August 2020. Resistance to early and late leaf spot in groundnut in Eastern and Southern Africa. Presentation at the Peanut Innovation Lab Graduate Student Conference (Virtual).

Okello, D. 2020. Enhancing the genetic potential of peanut production in Eastern and Southern Africa. Presentation at the Peanut Innovation Lab Annual Research Meeting, 2-4 June 2020 (Virtual).

Okello, D.K., Chapu, I., Ugen, A.M., Okori, P., Haile, D., Mwololo, J., Ojiewo, C., Leal-Bertioli, S., Balota, M. & Deom, C.M. 2020. Breeding for extra early and early drought tolerant groundnuts in Uganda. Presentation at the InterDrought Conference, Mexico City, Mexico.

Project A7. Enhancing the genetic potential of peanut production in West Africa

Research Locations

NARO-NaSARRI, Soroti, Uganda; CSIR-SARI, Tamale, Ghana; ISRA-CNRA, Bambey, Senegal; INRAN-CERRA Niamey, Niger; IER-CRRA, Bamako, Mali

Description

Africa is known to be a secondary center of diversity for cultivated peanut. Peanut breeders from different countries in Africa each hold small parts of this diversity which, put together, represent unique genetic resources that could be used to map traits of interest and add value to breeding programs. A panel of about 200-300 accessions will be tested across a range of environments and conditions (at least four countries in West Africa through this project and four in Eastern and Southern Africa through David Okello Kalule's project) to generate relevant information and data around diversity and the genetic basis for target traits, leading to a broadening of the genetic base for peanut breeding programs, and the development of new genes/markers for molecular breeding. The overall objective of the project is to characterize and document a unique pool of material that can be used as a new source of germplasm and alleles to improve peanut breeding in West Africa.

The accessions come from a set of 300 peanut lines from across Africa that have gone through phenotypic and genotypic evaluation in Senegal and Uganda. The set represents as much of the groundnut diversity across the African continent as possible but provides a set of a suitable size for multi-site evaluation in replicated trials. Breeders will evaluate this African core panel under local conditions in several countries in West Africa, including Ghana, Mali, Niger and Senegal.

Core panel performance will be evaluated running single and multi-environments (GxE) analysis from phenotyping data. Diversity analysis, bringing together phenotypic and genotypic data from this very diverse set of African accessions, will allow for a better understanding of the genetic diversity used by each breeding program in West Africa, and thus provide breeders with opportunities to enlarge the genetic pool of material they use as parental lines for new crosses. The same set of data will also allow genome-wide association studies (GWAS) to be run which will identify the genomic regions involved in the expression of target agronomic traits within a single environment, and across comparable ones. For simple inherited traits, association analysis could result in the identification of trait-linked markers that would be, after validation, suitable for crossing a trait into a variety. Genomic regions of interest for further gene pyramiding will also be identified for quantitative traits. Considering the performance of the core panel, some accessions performing well under specific local conditions might be considered as suitable donor lines for new crosses, or even ready to go directly into the national registration process.

Theory of Change/Impact Pathway(s)

Information on the genetic makeup of varieties and use of core sets based on this information allows breeders to broaden the diversity in their programs. This results in more resilient varieties delivered to farmers, increased yields, and ultimately improved household food security.

Collaborators

Daniel Fonceka (PI) and Aissatou Sambou, ISRA-CERAAS and Issa Faye, ISRA-CNRA, Senegal; Richard Oteng-Frimpong, CSIR-SARI, Ghana; Adama Coulibaly, INRAN-CERRA, Niger; Dramane Sako, IER-CRRA, Mali; Jean-Marcel Ribaut, IBP, Mexico; Peggy Ozias-Akins, UGA, GA; Josh Clevenger, HudsonAlpha Institute of Biotechnology, Huntsville, AL; Jean- Francois Rami & Joel Nguepjop, CIRAD, France

The African core germplasm collection is phenotyped in a trial at Nioro, Senegal, in 2019.

Achievements

The core collection (300 genotypes from the African germplasm collection) was phenotyped at Nioro under irrigation conditions. Short duration and long duration varieties were randomized separately and installed in two distinct trials sown in early October 2019. Three traits were recorded during the vegetative phase (plant height, plant spread, and leaf spot disease).

All genotypes were assessed for pod maturity before harvesting, providing a more precise determination of the duration of each variety. For example, among the varieties described by breeders as short duration, 27 were found to be long duration. Inversely, among the long duration varieties, 21 were found to be short duration.

Varieties were evaluated for total biomass, pod and haulm weight per plant, percentage of pods that are mature, and the weight of pods and seeds.

Seeded multiplication of the 300 core lines was completed and seed sent to the NARS partners in Mali, Niger and Ghana. Trials were planted at all locations in April 2020 and the collection of phenotypic data will be done using the BMS software system.

One tangential achievement of the project was the repopulation of germplasm to the Togo national program. Most of the Togo materials were lost due to power interruption, but because they had supplied 100 lines to Senegal for use in this project, seed of all 100 lines plus additional diverse lines were sent to Togo to restart the program.

Capacity Building

This project is tightly linked with the IFAD-funded EBCA project led by the Integrated Breeding Platform (IBP). The germplasm lists are being managed using the BMS. The experimental design for the off-season core-collection trial has been generated with the BMS and all phenotypic data will be uploaded in the BMS. Moreover, one IBP staff (Mariano Crimi) and two CIRAD scientists (Jean-François Rami and Guilhem Sempere) are working on the

interoperability between the Gigwa data-management application and the BMS thanks to BrAPI (Breeding Application Programming Interface) using the SNP genotyping, germplasm list and phenotyping data of the African peanut germplasm collection. This will connect the genotyping and the phenotyping data that are stored in different databases.

Lessons Learned

The first characterization of the core collection allowed the reclassification of the genotypes based on their maturity. The seed increase was sufficient to provide the West African partners with sufficient seed to set up their trials without having to go through a seed multiplication.

Presentations and Publications

Fonceka, D. 2020. Enhancing the genetic potential of peanut production in West. Presentation at the Peanut Innovation Lab Annual Research Meeting, 2-4 June 2020 (Virtual).

Fonceka, D., Sambou, A., Tossim, H., Kalule, D. O & Bertioli, D. 2019. Mobilizing genetic diversity for strengthening peanut breeding program in Africa. Presentation at AAGB Conference, Jinan, China.

Gomis, J., Kane, A., Sambou, A., Tossim, H., SEYE, M., DJIBOUNE, R. & Fonceka, D. Genetic improvement of resistance to early and late leaf spot on cultivated peanut (Arachis hypogea): QTLs mapping in an interspecific backcrossed population

Project A8. Use of novel genetic diversity for peanut varietal development in East Africa

Research Locations

NARO-NaSARRI, Soroti, Uganda; ISRA-CERAAS, Thiès, Senegal; University of Georgia, Athens GA, USA

Description

In this project, wild relatives of peanut are used to provide new alleles to improve cultivated species to have resistance to components of leaf spots and groundnut rosette disease (GRD). New lines containing some of these wild species are available at UGA and will be tested in Uganda. Three wild-derived advanced populations and several lines with resistant alleles have been produced in CERAAS (Senegal), and they will also be available for testing in Uganda. Selected, resistant progenies will be crossed with preferred peanut lines for the production of cultivars with higher levels of resistance to leaf spots and GRD.

Theory of Change/Impact Pathway(s)

Access to new and diverse germplasm allows breeders to broaden the diversity in their programs. This results in more resilient varieties delivered to farmers, increased yields, and ultimately improved household food security.

Collaborators

Soraya Leal-Bertioli (PI), David Bertioli, Mike Deom, Scott Jackson, Rajagopalbabu Srinivasan, Peggy Ozias-Akins, UGA, GA; David Okello Kalule, NARO-NaSARRI, Uganda; Daniel Fonceka, ISRA-CERAAS, Senegal; and Josh Clevenger, HudsonAlpha Institute, AL

Achievements

The 384 AB-QTL and CSSL lines were evaluated in the field at the NaSARRI station and at Nakabango for GRD, LLS, yield (pod yield per plant, dry pod weight, kernel weight, shelling percent), and farmer-preferred traits (pod reticulation, pod beak, pod constriction). A preliminary analysis of the data noted that most genotypes are susceptible to LLS but a few lines were resistant to GRD.

A second set of *Arachis diogoi* introgression lines were also evaluated in the field and over half of the lines showed no incidence of GRD and seven lines were highly resistant to leaf spot. These will lines be confirmed next season and used in crosses to transfer resistance to these diseases into released varieties.

This interspecific derivative showed the highest pod yield.

Thirty crosses among synthetic allotetraploids [*Arachis ipaensis* x *A. du*ranensis] 4x (IpaDur1) and [*Arachis baticozoi* x *A. duranensis*] 4x (BatDur) were made at NaSARRI with locally improved varieties (NARONUT 1T, NARONUT 1R, Serenut 9T, Serenut 11T, Serenut 8R and Serenut 14R). A total of 20 potential F_1 hybrids were obtained. For confirmation of hybridity, leaves were sent to UGA, DNA extracted and genotyped to confirm the hybrids.

Potential Naronut IT × IpaDur1 hybrid was developed.

Finally, 95 distinct genotypes involving *A. cardenasii* introgressions were sent to NaSARRI for evaluation and used in crosses with elite varieties. These lines are known to contain resistance to leaf spot.

Capacity Building

Staff members, students and technicians from the cereal and dryland legumes programs in NARO were trained on the new features in the most recent version of the Breeding Management System (BMS Version 14.0) during a two-day training workshop held at NaSARRI in February.

Lessons Learned

Rainfall patterns have changed drastically with more rain received this past season than usual. This has become a problem especially for non-uniform parts of the field. This may require additional years to better characterize the materials.

High temperature that does not favor growth, flowering and pegging outside of buckets in the NaSARRI screenhouse have made it difficult to obtain sufficient seeds from synthetic allotetraploid. This may limit the size of future field trials with these materials. Additional crosses are planned.

Presentations and Publications

Bertioli, D., Fonceka, D. & Leal-Bertioli, S. 2020. Incorporating new wild alleles to improve elite West African peanut cultivars. Presentation at the Peanut Innovation Lab 2020 Annual Research Meeting (Virtual).

Leal-Bertioli, S., Bertioli, D., Fonceka, D. & Kalule, D. O. 2020. Use of novel genetic diversity for peanut varietal development in East Africa. Presentation at Peanut Innovation Lab 2020 Annual Research Meeting (Virtual)

Essandoh, D. A., Kalule, D. O. & Leal-Bertioli, S. 2020. Performance of Interspecific and Synthetic Allotetraploids in Uganda. Presentation at the Peanut Innovation Lab Graduate Student Conference (Virtual).

Essandoh, D. A., Odong, T., Leal-Bertioli, S. & Kalule, D. O. Performance of inter specific lines of groundnut in Uganda

Leal-Bertioli, S. 2020. Use of novel genetic diversity for peanut varietal development in East Africa. Presentation at the Peanut Innovation Lab Annual Research Meeting, 2-4 June 2020 (Virtual).

Okaron, V., Okello, D, Mwolo, & Leal-Bertioli, S. August 2020. Resistance to Early and Late leaf spots in Groundnut (Arachis hypogaea L.) in Eastern and Southern Africa. Presentation at the Peanut Innovation Lab Graduate Student Conference (Virtual).

Project A9. Incorporating new wild alleles to improve elite West African peanut cultivars

Research Locations

ISRA-CERAAS, Thiès, Senegal; University of Georgia, Athens, GA, USA

Description

Genetic variation in peanut is limited due to its recent, unique, polyploid origin, which limits crop improvement through breeding. Wild relatives of peanut are a rich source of alleles that have arisen over millions of years of natural selection in diverse environments. However, in early generation hybrids, the valuable wild alleles are masked by the more numerous unfavorable wild alleles that confer poor growth habit, small seed size, etc. These “cryptic” favorable wild alleles can be discovered through multiple cycles of backcrossing and screening for favorable traits when the wild alleles are incorporated with a substantially cultivated peanut genetic background.

Previous projects using this strategy have developed varieties that are resistant to late and early leaf spot. From the first highly backcrossed population, six new varieties were released in Senegal – with improved yield stability, haulm mass, higher yield and larger seeds. The proposed work will build on these successes, evaluating a previously developed set of lines and laying the foundation for the production of new ones. Promising lines will be tested for cultivar release and/or incorporated into breeding programs. Materials produced will form a publicly available resource.

Theory of Change/Impact Pathway(s)

Access to new and diverse germplasm allows breeders to broaden the diversity in their programs. This results in more resilient varieties delivered to farmers, increased yields, and ultimately improved household food security.

Collaborators

David Bertioli (PI), Soraya Leal-Bertioli, Scott Jackson and Peggy Ozias-Akins, UGA, GA; Daniel Fonceka, ISRA-CERAAS, Senegal

Achievements

Over 160 cuttings from the hybrids obtained in 2019 (*Arachis magna* x *A. diogoi*)2x and (*A. ipaensis* x *A. aff.*)2x were treated with colchicine for genome tetraploidization. Two successful *A. magna* x *A. diogoi* allotetraploids were obtained. The cuttings from *A. ipaensis* x *A. aff.* are still in the process of tetraploidization (it takes several months). Hybridity from the other four crosses was confirmed and colchicine treatment started to produced tetraploids.

The following eight additional interspecific crosses were made: *A. cruziana* Grif 14257 x *A. microsperma* Grif 15116, *A. cruziana* PI 476003 x *A. microsperma*, PI 654500, *A.valida* PI 666103 x *A. kuhlmannii* PI 666095, *A. valida* PI 666102 x *A. kuhlmannii* PI 476108, *A. magna* PI 468337 x *A. simpsonii* Grif 14534, *A. magna* PI 599184 x *A. simpsonii* PI 674413, *A. batizoco*i PI 468325 x *A. kempff-mercadoi* PI 468330, *A. batizocoi* K9484 x *A. kempff-mercadoi* PI 468334. From all crosses, pegs were obtained and hybridity confirmed.

This potential diploid hybrid of A. magna x A. hoenei was made in 2019; the hybrid was recovered in 2020.

A total of 782 BC_2F_2 and BC_3 plants were genotyped using SNP-KASP panel to select 23 BC3 individuals from the cross between Fleur11 and CS16 that carried different combinations of LLS and rust QTLs at chromosomes A02 and A03, respectively.

BC_2 lines from the cross between 73-33 and CS16 carrying the LLS and rust QTLs have been identified. Their advancement to the BC_3 generation has b een slowed because of the COVID-19 crisis. Selected BC_2 seeds are stored at CERAAS cold-room and will be planted as soon as practicable.

The 250 individual AB-QTL population from the cross between Fleur11 and (*A. ipaensis* x *A. correntina*) 4x is currently sown at ISAR-CERAAS. DNA was extracted from individual plants and ready for shipment to UGA for genotyping. The plants will be self-pollinated to produce families that will be phenotyped at ISRA Nioro research station for leafspot and yield component traits this coming season. (This activity was supposed to start in July 2020, but began ahead of schedule).

Capacity Building

The Senegalese team is gaining experience in the handling and evaluation of wild-crossed materials. This is important in their efforts to enhance the genetic diversity of peanut in the national program.

Lessons Learned

The long-standing collaboration between UGA and ISRA-CERAAS scientists has made it easy for all activities to be conducted on-time (and even ahead of time) and without serious issues.

Presentations and Publications

Bertioli, D. 2019. International Collaboration Leverages Peanut Research and Crop Improvement from the peanut genome project. Presentation at the 51st Annual Meeting American Peanut Research and Education Society, Auburn, AL USA.

Bertioli, D. 2020. Incorporating new wild alleles to improve elite West African peanut. Presentation at the Peanut Innovation Lab Annual Research Meeting, 2-4 June 2020 (Virtual).

Project A10. Developing *Aspergillus flavus*-resistant peanut using seed coat biochemical markers

Research Locations

ICRISAT, Niamey, Niger; ICRISAT, Patancheru, India; Texas Tech University, Lubbock, TX, USA

Description

The project studies the development of the seed coat of peanut and whether increasing naturally occurring biochemicals in the seed coat can increase the resistance to *Aspergillus flavus*, the fungus that can produce aflatoxin. The aim of the project is to fortify the seed coat with cell wall/antimicrobial compounds to confer pre- and post-harvest *A. flavus* resistance in peanut. Specific objectives of the project are to: 1) discover seed coat biochemical(s) associated with *A. flavus* resistance; 2) develop biochemical Marker Assisted Selection (bMAS) pipeline for breeders in target countries, and 3) develop *A. flavu*s resistant line(s) for field deployment in target countries.

Theory of Change/Impact Pathway(s)

The information gained from the research will allow researchers to identify lines that have new resistance to pathogen infection and reduced mycotoxin contamination. These lines can be used by breeders to develop more resilient varieties and release these to farmers. Use of the new varieties as food and feed will reduce the effects of mycotoxins to human and animal health.

Collaborators

Venugopal Mendu (PI), Texas Tech University, TX; Mark Burow, Texas A&M University, TX; Hamidou Falalou, ICRISAT, Niger; Hari Sudini, ICRISAT, India

Achievements

A total of 68 lines obtained under the previous Peanut and Mycotoxin Innovation Lab and from the USDA germplasm collection have been screened using the *in-vitro* seed colonization assay for *Aspergillus flavu*s resistance. One resistant line (PI 544346) has been identified that shows better resistance compared to the resistant check 55-437.

Compounds extracted from seed coats of 55-437 (resistant) and TMV-2 (susceptible) lines have been identified that show inhibition of *Aspergillus flavus* growth. These will be analyzed further to confirm the results and determine the specific compounds involved.

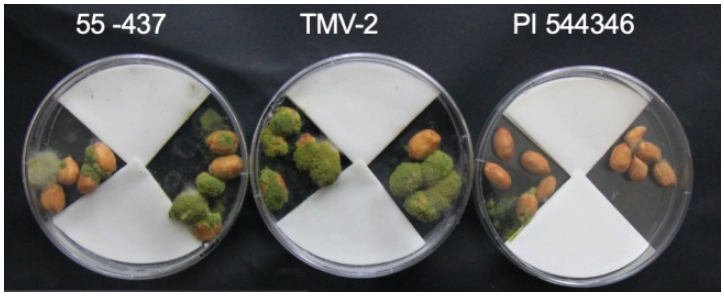
Crosses were made between TMV-2 and 55-437 and genotyping of the F_3 is underway. The population will be used to determine the inheritance pattern of the seed coat biochemicals responsible for *A. flavus* resistance.

Capacity Building

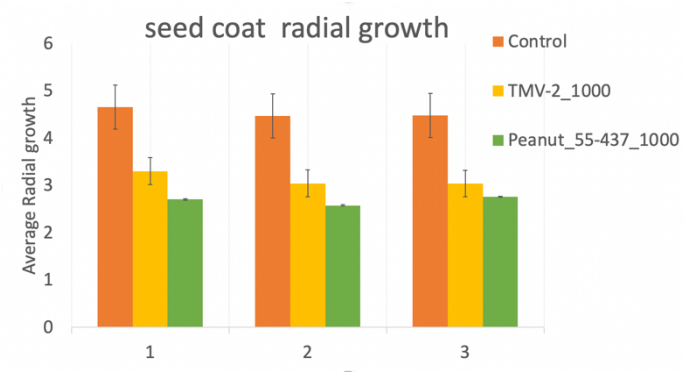
A planned training workshop for the African scientists and students at Texas Tech University has been postponed due to COVID-19 travel restrictions.

Lessons Learned

From the screening, it appears that lines with a tan seed coat are more resistant. We are therefore planning to screen an additional 40 tan lines from the USDA germplasm collection.



Work included in-vitro screening for A. flavus resistance.(above) as well as analysis of seed coat growth through different experiments (below).



Presentations and Publications

Commey, L., Falalou, H., Burow, M., Sudini, H., & Mendu, V. 2020. Developing Aspergillus flavus resistant peanut using seed coat biochemicals. Presentation at the Peanut Innovation Lab Graduate Student Conference (Virtual).

Commey, L., Tengey, T. K., Falalou, H., Burow, M., Sudini, H. & Mendu, V. 2020. Seed coat biochemicals mediates Aspergillus flavus resistance in peanut. Presentation at the 52nd American Peanut Research and Education Society Meeting (Virtual).

Mamane Moutari, A. A., Falalou, H. & Mendu, V. 2020. Identification of biochemical and physiological traits for peanut seed coat resistance to Aspergillus flavus colonization and aflatoxin contamination. Presentation at the Peanut Innovation Lab Graduate Student Conference (Virtual).

Mariama, H. T., Falalou, H. & Mendu, V. 2020. Developing Aspergillus flavus resistant peanut using seed coat biochemical markers. Presentation at the Peanut Innovation Lab Graduate Student Conference (Virtual).

Mendu, V. 2020. Developing Aspergillus flavus-resistant peanut using seed coat biochemical markers. Presentation at the Peanut Innovation Lab Annual Research Meeting, 2-4 June 2020 (Virtual).

Project A11. Mapping Groundnut Rosette Virus (GRV) resistance for marker-assisted selection

Research Locations

NARO-NaSARRI, Soroti, Uganda; DARS-Chitedze Research Station, Chitedze, Malawi; ICRISAT, Nairobi, Kenya; University of Georgia, Athens, GA, USA

Description

Groundnut rosette disease (GRD) caused by the groundnut rosette virus (GRV) complex is the most destructive peanut disease in sub-Saharan Africa. Resistance has been introduced into locally grown varieties and is a perfect target for genomics-assisted selection to integrate

resistance into future varieties. The genetic mapping resources are available for marker development, but the capacity to develop a marker tightly linked to resistance needs to be developed and implemented using the latest genomics technology and expertise.

The project will develop diagnostic molecular markers that can be used to select for GRD resistance using existing recombinant inbred lines (RIL) populations that are segregating for resistance to GRD, but not the virus vector. We will combine strong phenotypic data with classical QTL mapping using high density SNP markers from the Axiom_Arachis2 SNP array. In addition, we will carry out QTL-seq analysis using bulked tails of the phenotypic distribution. This analysis will provide population-specific markers as well as whole genome selection for the resistant parent, ICGV-SM 90704. Markers will be evaluated in GRD hotspots in Malawi and Uganda. Additional results will be accrued from association analysis of an African diversity set that is being screened in Uganda as part of another initiative led by David Okello Kalule and Daniel Fonceka. The total effort is expected to produce strongly linked marker(s) to GRD resistance that can be deployed in breeding programs in collaboration with Intertek genotyping services. The marker(s) will be used to select efficiently for resistance so that other high-value traits can be introgressed into locally adopted varieties for rapid genetic improvement.

Theory of Change/Impact Pathway(s)

Tools to select for resistance to GRD will allow breeders to develop more resistant varieties. These varieties can then be delivered to farmers, increasing yields, and ultimately improving household food security.

Collaborators

Josh Clevenger (PI), HudsonAlpha Institute, AL; Damaris Odeny, ICRISAT, Kenya; Peggy Ozias-Akins, UGA, GA; David Okello Kalule, NARO-NaSARRI, Uganda

Achievements

The groundnut rosette disease mapping population, consisting of 150 genotypes, was planted in pots set up in the glasshouse at ICRISAT's Chitedze Research Station in Malawi. The plants were artificially inoculated with the virus through GRD-carrying aphids 14 and 21 days after planting. Response of the genotypes differed with some showing infection while some were resistant.

Qualitative scores (+/- presence or absence) for GRD were collected at 7, 14 and 21 days after the second inoculation. The scores showed that some genotypes had the GRV infection from the initial day of assessment while some genotypes showed the GRV infection during the second or third scoring. The population was genoptyped using the SNP array and the data indicates a major gene for GRD resistance on chromosome 4 (A04). Once confirmed, this will lead to the development of markers for GRD resistance.

To confirm the genetics, crosses were initiated between GRV resistant peanut line Serenut 2 and susceptible line Serenut 1, as well as GRV resistant ICGV91707 and Serenut 1. These crosses are being conducted in Senegal by Daniel Fonceka. QTL sequencing of resistant and susceptible bulks will be used to confirm the genetic location and ultimately, the gene for resistance.

Genotypes react to GRV after inoculation, showing one is resistant (left), one has intermediate resistance (center) and one is susceptible (right).

Capacity Building

Initiated a new partnership with Daniel Fonceka at ISRA/CERAAS in Thiès, Senegal to produce new segregating populations for use in genetic mapping. Lutangu Makweti, from ZARI in Chipata, has been recruited as a PhD student and will conduct research on the genetics of GRD resistance at the University of KwaZulu-Natal.

Lessons Learned

The importance of a good genetic population cannot be overstated, which is why we have had to generate a new population for the project. Reaching out to the network of scientists in the Peanut Innovation Lab helped identify proper parental materials and an offer to help quickly.

Presentations and Publications

Achola, E., Odeny, D. A., Tukamuhabwa, P., Clevenger, J. Edema, R., Gibson, P., Deom, C. M. & Kalule, D. O. 2019. Understanding the genetics of groundnut rosette disease resistance. Presentation at the 1st African Plant Breeders Association International Conference, October 23-25, 2019, Accra, Ghana.

Achola, E., Odeny, D. A., Wasswa, P., Clevenger, J., Edema, R., Gibson, P. & Kalule, D. O. 2020. Mapping of genomic regions associated with resistance to groundnut rosette disease in cultivated peanut (Arachis hypogaea L. Presentation at the National Association of Plant Breeders (NAPB) 2020 Annual Meeting, University of Nebraska, Lincoln, Nebraska, USA.

Achola, E., Wasswa, P., Odeny, D. A., Clevenger, J. & Kalule, D. O. 2020. Understanding the genetics of resistance to groundnut rosette disease. Presentation at the Peanut Innovation Lab Graduate Student Conference (Virtual).

Clevenger, J. 2020. Mapping groundnut rosette virus (GRV) resistance for marker-assisted selection. Presentation at the Peanut Innovation Lab Annual Research Meeting, 2-4 June 2020 (Virtual).

Project A12. Breeding for tolerance to water deficit, resistance to leaf spot and improved oil composition in peanut

Research Locations

CSIR-SARI, Tamale, Ghana; ISRA-CNRA, Bambey, Senegal; Texas A&M University, Lubbock, TX, USA

Description

Drought-stress and leaf spots are two of the major contributing factors to the yield deficit of peanuts in Africa. This project enhances genetic diversity of peanuts to reduce the impacts of these stresses through the use of wild species, genetic populations generated in the USA and West Africa, and selected ICRISAT breeding lines. Genes for tolerance to water deficit, resistance to leaf spots, and enhanced oil composition will be transferred to breeding programs in Ghana and Senegal and used to develop improved varieties. DNA markers will be identified for tolerance to water deficit stress and resistance to leafspots. DNA markers will be shared with national programs and training provided for use in selecting for these traits and for the high oleic acid content. Multi-location trials will be conducted with the goal of identifying release candidates for new varieties.

Theory of Change/Impact Pathway(s)

Using tools to select for better yield under drought and pest pressure results in more resilient varieties delivered to farmers, increased yields, and ultimately improved household food security.

Collaborators

Mark Burow (PI) and Charles E. Simpson, Texas A&M University, TX; Richard Oteng-Frimpong, CSIR-SARI, Ghana; Issa Faye, ISRA-CNRA, Senegal

Achievements

In developing peanut varieties with tolerance to water deficit stress, we have not been successful in doubling the chromosomes of the *Arachis dardani* hybrids. As a result, we have had to go back and make additional hybrids because the colchicine treatments have killed all of our hybrids to date. Putative 4-way F1 hybrids from the crosses (78-936 x 55-33) x (Rafet Kar x Schubert) and (ICGV 96894 x 73-30) x (ICGV 86124 x 55-437) have been developed and crosses between these 4-way F1 hybrids completed. Seed of 94 breeding lines of 55-437 (drought tolerant and *Aspergillus flavus* resistant line) x Schubert have been sent to CSIR-SARI, but a seed increase will be needed before evaluation is feasible in Ghana. Seed was also provided to Venu Mendu for analysis for *A. flavus* resistance. SNP data on the US mini-core collection have been received and will be combined with field evaluation of the population for GWAS analysis.

For tolerance to leaf spots, field evaluation demonstrated significant differences in resistance among lines having interspecific donor parents. QTL analysis of field data taken in Ghana in 2019 for leaf spot scores identified one simple sequence repeat (SSR) marker that was significant for pod number, harvest index, and biomass. In a second population, the same SSR marker was significant for leaf spot score, biomass, and harvest index. A second SSR marker was significant for plant height. Further analysis of the data revealed that we are missing maps for two linkage groups. We are awaiting synthesis of additional primers to fill in gaps in the SNP-based map. Once this is completed, we will finish QTL analysis. Evaluation of the Nkatiesari x Schubert breeding line population continued in the rainy season in Ghana with 50 selected lines. After the evaluation, single plant selection was made from 13 of the selected lines. Seeds from the selected plants are currently being multiplied under irrigation. A full replicated yield trial will be established during the main planting season. Crosses were made to combine resistance to leaf spots with the high oleic trait in runner peanuts.

The release, registration and cataloguing of SARINUT 1 was completed. The main characteristics include yield potential of 2.6 t/ha, 120 days to maturity, early and late leaf spot resistance, 51% oil with high oleic acid and 26% protein, high haulm yield with 12.2% crude protein, dual-purpose confectionery and oil-extraction type. Seed production of early generation seed of SARINUT 1 was harvested in December 2019. Currently, 1.5 tons of seed is available for partners to multiply in the coming year.

Capacity Building

The project is assisting the HTP project, Project A5, to develop the capacity to conduct oil analysis of groundnut lines at ISRA (Senegal) and CSIR-SARI (Ghana).

Lessons Learned

The COVID-19 pandemic is already affecting the ability to conduct some experiments and may delay progress.

Presentations and Publications

Burow, M. 2020. Breeding and enhancement of tolerance to water deficit, resistance to leaf spot and improved oil composition in peanut. Presentation at the Peanut Innovation Lab Annual Research Meeting, 2-4 June 2020 (Virtual).

Burow, M., Chagoya, J., Kulkarni, R., Baring, M. R. & Simpson, C. 2019. Evaluation of a population developed for tolerance to water deficit, introgressed from the peanut minicore collection. Presentation at the Annual Meeting of the Crop Science Society of America, San Antonio, TX USA.

Burow, M., Chagoya, J., Kulkarni, R., Belamkar, V. & Chopra, R. 2020. Validation of the utility of GWAS-derived markers for tolerance to water deficit in a segregating peanut breeding population. Presentation at the Plant and Animal Genome Conference, San Diego, CA USA.

Commey, L. 2020. Developing Aspergillus flavus resistant peanut using seed coat biochemical markers. Presentation at the Peanut Innovation Lab Graduate Student Conference (Virtual).

Commey, L., Sudini, H., Falalou, H., Tengey, T. K., Burow, M. & Mendu, V. 2020. Seed Coat Biochemicals Mediates Aspergillus flavus Resistance in Peanut. Presentation at the 52nd American Peanut Research and Education Society Meeting (Virtual).

Niendow, J. Z. 2020. Genetic variation for drought tolerance and oil quality traits in a groundnut population using remote sensing technologies. Presentation at the Peanut Innovation Lab Graduate Student Conference (Virtual).

Sanon, E., Lomadji, S. S., Dabire, K., Bertin, Z., Burow, M. & Sankara, P. 2019. Evaluation in Gampela (Burkina Faso) of agronomic performances of peanut genotypes (Arachis hypogaea L.) selected in Texas. Journal of Agricultural Biotechnology and Sustainable Development 11(3) 48-55. doi:10.5897/JABSD2019.0356.

Tengey, T. K., Simpson, C., Denwar, N., Sankara, P. & Wilson, J. 2020. Identification of QTLs for leaf spot and rust resistance in a BC3F6 interspecific peanut introgression population in West Africa and Texas using SNP markers. Presentation at the Plant and Animal Genome Conference, San Diego, CA USA.

B. Value-Added Gains Research Project Reports

Project B1. Updating of the NCSU Risk Index Tool [COMPLETED]

Research Locations

NCSU, Raleigh, NC, USA

Description

This completed commissioned project updated the existing web-based North Carolina State University (NCSU) risk index software tool into a form that can be used in other US states and Peanut Innovation Lab countries to help farmers make informed decisions about production practices, including disease and pest management. The tool is being updated to allow extension specialists and others more easily to add data required for decision-making, thus making the tool available in other countries.

Theory of Change/Impact Pathway(s)

The risk tool is intended to be used by extension agents and farmers to determine the best management practices to use in the upcoming cropping season. Successful use of the tool would result in increased and more profitable yields for farmers.

Collaborators

David Jordan (PI), Greg Buol, Gail Wilkerson, Rick Brandenburg, Barbara Shew, NCSU, NC

Project B2. Groundnut rosette disease (GRD) alternative host

Research Locations

NARO-NaSARRI, Soroti, Uganda; NARO-NaCRRI, Kampala, Uganda; University of Georgia, Athens, GA, USA

Description

The objective of this project is to identify alternate host(s) of groundnut rosette disease, which is the most destructive viral disease of groundnut in sub-Saharan Africa. This project will analyze possible hosts from major groundnut producing areas in Uganda where the disease occurs at a high incidence each growing season.

Theory of Change/Impact Pathway(s)

Groundnut rosette virus only exists in Africa, although the aphid vector of the diseases exists in many parts of the world, and most peanut varieties are susceptible. Identification of the alternate host would allow researchers to develop more sustainable strategies to contain the disease. Such knowledge would also identify strategies for restricting migration of the disease to countries outside of Africa. Reducing the risk creates more sustainable yields around the globe.

Collaborators

Mike Deom (PI) and Paul Severns, UGA, GA; David Okello Kalule, NARO-NaSARRI; Michael Hilary Otim, NARO-NaCRRI, Uganda

Achievements

Two surveys were conducted with 20 aphid samples and 90 plant samples collected from potential alternate hosts in June and September 2020. All samples were geo-referenced and descriptive data collected. Seed was collected when possible. Insect cages for rearing colonies of the aphid, *Aphis craccivora,* have been constructed and are located in a screenhouse at NaCRRI. Colonies of aphids are being grown and increased. Seed of a likely alternate host, *Senna obtusifolia*, has been planted and germinated well. These will be used to verify the presence of the virus and to test the species' ability to transmit the disease.

A grad student collects samples in Uganda.

Capacity Building

Improvements to the insectary are completed, allowing studies to commence. Students and co-PIs participated in a GREAT-run training program on gender-responsive research in March and gave positive feedback about the usefulness of the information. Project partners continue to create linkages with the Peanut IL-funded variety development projects creating novel diversity and mapping GRD resistance.

Lessons Learned

Locust and groundnut leaf miner have had additional pressure this season and will require contingency plans in the future. Access to supplementary watering during the second rainy period are necessary for research sites in the future. Procurement delays within the NARO system has limited access to consumables delaying the student research.

Presentations and Publications

Deom, M. 2020. Identifying the alternative host for groundnut rosette disease virus complex. Presentation at the Peanut Innovation Lab Annual Research Meeting, 2-4 June 2020 (Virtual).

Ssendagire, H. 2020. GRD-Alternative Host Project. Presentation at Peanut Innovation Lab Research Meeting, Kampala, Uganda.

Ssendagire, H. 2020. Initial survey for GRD agents and nonviruliferous aphid colony culturing. Presentation at the Peanut Innovation Lab Graduate Student Conference (Virtual).

Project B3. Optimized Shrub System (OSS): an innovation for landscape regeneration and improved resilience for the peanut-basin of Senegal

Research Locations

University of Thiès (ENSA), Thiès, Senegal; ISRA-CNRA, Bambey, Senegal, The Ohio State University, Columbus, OH, USA

Description

This project aims to further refine and overcome challenges to adoption of the Optimized Shrub System (OSS), which increases the density of native shrubs purposely planted in farmers' fields and incorporates shredded shrub material into the soil, resulting in yield stability in the face of drought, improved soil fertility and resilience of the peanut/millet cropping system.

The project involves participatory surveys and focus sessions to gather information and design local adaptations to the OSS, measuring the effectiveness of OSS adoption by conducting on-farm trials with 20 households, researching peanut varieties best adapted for OSS, and conducting outreach.

Theory of Change/Impact Pathway(s)

Understanding the factors that prevent farmers from adopting the shrub system may help produce new strategies to achieve widespread use. The increased density of the shrub system shows evidence of improved resilience to drought and yield improvements.

Collaborators

Richard Dick (PI) and Amanda Davey, The Ohio State University, OH; Ibrahima Diedhiou and Idrissa Wade, University of Thiès, Thiès, Senegal**;** Issa Faye and Alfred Tine, ISRA- CNRA, Bambey, Senegal

Achievements

The 2019 rainy season on-farm demonstration trials were completed with the peanut harvest and the collection of soil samples between the end of October and December. A workshop to evaluate the 2019 experimental campaign and share the results obtained was organized in Meckhe on 12 February in collaboration with the farmers' organization UGPM.

Demonstration trials have been set up in 30 farming plots, 15 in the north (Meckhe zone) and 15 in the south (Nioro zone) with millet as a crop. Follow-up of these trials is in progress (measurement of crop and soil parameters; crop maintenance; shrub management.

A varietal test with and without optimized shrubs system (OSS) was planted at Nioro and Keur Matar (OSS long term field) in Senegal. At Keur Matar field trial, varieties being tested are 78-936, 55-33, 55-437, Raw Gadu and 73-33. The first four varieties are early maturing while 73-33 is a medium maturing. The variety 55-437 is the local variety which is planted across West African countries because of its tolerance to drought and aflatoxin contamination. At the Nioro field trial, the material included Raw Gadu, 73-33, Essamaay, 28-208 and H75-0. Essamaay is a newly released that is medium maturing variety (110 days) with large seed size. H75-0 is a confectionery type variety and late maturing (120 days) as is 28-206. 73-33 and 28-206 are local varieties which are largely cultivated in the Southern region of the Senegalese peanut basin.

In addition to testing plots with OSS and without OSS, the project considered a second factor, mineral fertilizer with 5 rates (0 kg/ha, 75 kg/ha, 150 kg/ha and 225 kg/ha). Researchers continue to collect data on plant growth, as well as flowering, pegging and other reproductive traits. In parallel to the varietal test, a micronutrient test is ongoing at both Nioro and Keur Matar. This trial aims to assess the effect of micronutrients (Ca, Mg, Mn) on the yield and yield components. Researchers hypothesize that micronutrients will improve pod-filling and yield, since micronutrient depletion (along with organic depletion and a long period of cultivation) limit peanut productivity in the area.

Richard Dick and Amanda Davey from The Ohio State University collaborate with Ibrahima Diedhiou of University of Thiès to validate that the optimized shrub system improves peanut productivity, as it has been shown to do in sorghum and other crops.

Capacity Building

A workshop entitled "Shrub Propagation Techniques and Optimized Shrub System Management" was held in February for the participant households in the northern site of Meckhe with 31 participants. In addition to training on propagation and management, an evaluation of the first year's growing season was given. This session was informal, allowing for dialog and discussion with participants on their experiences and how to strengthen the collaboration.

The project continues collaborations with ISRA/CNRA in Bambey, the University of Thiès, NGO Symbiose in Nioro, and the Makhfousse Sarr Farmers' Cooperative in Meckhe, as well as a new partnership with Trees for the Future (TREES), a U.S.-based NGO with projects across Sub-Saharan Africa. TREES has a large footprint in Senegal, including 250 technicians, motor bikes, and between 3,000 and 5,000 participating farmers. Project leaders are working with TREES on a large proposal that would combine their Forest Garden Approach for irrigated fruits and vegetables with OSS for rain-fed crops (millet, groundnut, cowpea, cassava) and have received a small grant from the Food, Conservation, & Health Foundation to establish an Agro-Shrub Farm Network as demonstration and training sites for OSS. Green Agro Consulting is a new partner who will be establishing one of the farms at their existing farm located near Saly.

Lessons Learned

There continues to be a large difference in uptake and enthusiasm between the farmers at Mekhe and the farmers at Nioro. The Meckhe farmers already are seeing the benefits of OSS, and the dedication and commitment to the project is strong. Some of the Nioro farmers still are

somewhat reluctant and have a mindset that they should be receiving payment to participate. In part, this was due to delayed funding the first year, which made it more difficult to vet farmers, who were selected by the NGO Symbiose, which has paid farmers in the past for project participation. This issue carried into June 2020 because of COVID-related travel restrictions. Subsequently, the project has reengaged with the Nioro farmers and added additional farmers who have expressed a commitment to full collaboration.

Farmers may apply to participate in a research and development program with motivations other than those considered by the researchers, and the recruitment of a person who resides in the experimentation sites to raise awareness and monitor the trials is essential to the success of a research program in a farming environment that aims to adopt an innovation.

Presentations and Publications

Dick, R. 2020. Optimized Shrub System (OSS): an innovation for landscape regeneration and improved resilience for the peanut-basin of Senegal. Presentation at the Peanut Innovation Lab Annual Research Meeting, 2-4 June 2020 (Virtual).

Dick, R. 2020. Optimized Shrub-Intercropping in the Sahel-17 Years Research: Agronomic Performance and Soil Quality. Presentation at the Sustainable Intensification Conference, Dakar, Senegal.

Ndiaye, N. Z. July 27, 2020. Effet du système optimisé à Guiera senegalensis sur des indicateurs de la qualité des sols et la performance agrophysiologique de l'arachide au nord bassin arachidier. Ecole Nationale Agriculture Thiès (ENSA).

Project B4. Peanut production packages for Ghana

Research Locations

CSIR-SARI, Tamale, Ghana; CSIR-CRI, Kumasi, Ghana; KNUST, Kumasi, Ghana

Description

Peanut yields continue to be low in Ghana compared with those of other countries where new technologies and resources are available to farmers. Food safety also is compromised through aflatoxin contamination in Ghana because of poor drying and storing techniques. Previous research through the Peanut CRSP and PMIL focused on variety development, integrated pest management, and aflatoxin reduction throughout the peanut value chain. Deployment of new technologies in Ghana has been effective in some areas but continues to be limited across the country. A major challenge is a weak seed supply chain that can deliver improved varieties and production packages that can increase yield, quality and farmer income.

To address these and other important issues facing farmers and the agriculture sector associated with peanut, this project is focused on four objectives: (1) improving and scaling-up production packages that increase peanut production and quality, (2) evaluating peanut-cereal cropping intensity and sequence to promote increased income and food security, (3) developing and deploying a risk tool for peanut production, and (4) improving linkages among public and private sector partners along the peanut value chain. Through these four objectives, a framework for collaboration among partners in Ghana will be fostered, farmers will receive pertinent information that will enable them to increase yield and improve food safety, and human capacity will be enhanced.

Theory of Change/Impact Pathway(s)

Adoption of technologies that improve peanut production is limited due to access to inputs, such as improved varieties, but also lack of knowledge about cost/benefits of technologies used as a package. This research will generate and share knowledge related the package-based approach that may help improve productivity.

Collaborators

David Jordan (PI) and Rick Brandenburg, North Carolina State University, Raleigh, NC; Moses Brandford Mochiah, CSIR-Crops Research Institute, Kumasi, Ghana; Mumuni Abudulai, CSIR-Savanna Agricultural Research Institute, Tamale, Ghana; Richard Akromah, Kwame Nkrumah University of Science and Technology (KNUST), Kumasi, Ghana; Greg MacDonald, University of Florida, Gainesville, FL; Maria Balota, Virginia Tech, Suffolk, VA

Achievements

Due to COVID-19 restrictions, it was not possible to initiate the on-farm trials in northern Ghana. The project scientists are considering potential alternative sites if the restrictions are not lifted by next season.

To assess the quality of peanut seed available from various sources, seed samples were collected from 46 farmers, 45 markets and 9 research institutes. Samples have been analyzed for moisture, physical purity and germination testing using sand as the medium. Based on the results, seed germination was found to be low in all samples, ranging from 51% for seed from markets, 54% farmer-saved and 66% for institution-produced seed. DNA analysis is underway to determine the identities of the varieties. An associated survey of 200 farmers indicated that farmers agree that quality seed results in better yields and that certified and farmer-saved seed are of the highest quality.

A PhD student is conducting the second year (July-Nov 2020) of data collection on crop rotation trials at three locations (on station at CRI-Kumasi, and one site each near Tamale and Wa).

The second annual meeting of the Ghana Groundnut Working Group was held in Tamale on March 11-12. While the initial warnings of COVID-19 in Ghana limited some participation, especially of international collaborators, 40 people (nine female, 31 male) participated, including farmers, aggregators, processors, NGO/development professionals and researchers. A journalist from the Ghana News Agency attended and wrote a piece for the local press. Participants at the meeting assembled a list of all biotic and abiotic stresses in peanut for both northern and southern Ghana, along with a ranking of which are the most economically damaging and which control practices are available. This information will be used to develop the initial version of the risk tool developed at NCSU to protect peanut yield and mitigate aflatoxin.

Capacity Building

An entirely Ghanaian GGWG leadership team organized a well-attended meeting this year that linked public and private sector interests in the value chain. One additional output of the meeting was an organizational plan for sustainability of the meeting and increased attendance from private sector in the future. This meeting has also improved the targeting of research priorities based on feedback from different sectors and will continue to serve in this function throughout the project and beyond.

Lessons Learned

The GGWG format, based on the APRES meeting in the US, will need to adapt continually to the local context in Ghana to assure relevance to all sectors. The meeting has also brought attention to the challenges of the groundnut value chain, such as a successful seed system and aflatoxin management, that have limited the advances of groundnut relative to other crops, including grain legumes like soy and cowpeas, which have similar challenges.

Presentations and Publications

Abdul Hafiz, A. 2020. Developing manual groundnut sorting standard. Presentation at 2nd Ghana Groundnut Working Group (GGWG) Meeting, Tamale, Ghana.

Abogoom, J. 2020. Evaluation of perceptions, preferences and quality of groundnut seeds in Ghana. Presentation at 2nd Ghana Groundnut Working Group (GGWG) Meeting, Tamale, Ghana.

Abudulai, M. 2020. Future activities of the GGWG. Presentation at 2nd Ghana Groundnut Working Group (GGWG) Meeting, Tamale, Ghana.

Abudulai, M. 2020. Purpose of the GGWG. Presentation at 2nd Ghana Groundnut Working Group (GGWG) Meeting, Tamale, Ghana.

Akromah, R. 2020. Highlights of the 2019 Ghana Groundnut Working Group (GGWG) Meeting. Presentation at 2nd Ghana Groundnut Working Group (GGWG) Meeting, Tamale, Ghana.

Appaw, W. 2020. Approaches to Minimizing Aflatoxin Contamination in the Field, During Drying, and in Storage in Southern Ghana. Presentation at the 52nd American Peanut Research and Education Society Meeting (Virtual).

Appaw, W. 2020. The battle against aflatoxin contamination in groundnut in Ghana: The story so far. Presentation at 2nd Ghana Groundnut Working Group (GGWG) Meeting, Tamale, Ghana.

Appaw, W., Ellis, W. O., Akromah, R., Mochiah, M. B., Dankyi, A., Abudulai, M., Jordan, D. L., Brandenburg, R. L., Jelliffe, J., Bravo-Ureta, B. E., Boote, K., MacDonald, G., Chen, J., Phillips, R. D., Mallikarjunan, K., Balota, M., Hoisington, D. & Rhoads, J. 2020. Minimizing aflatoxin contamination in the field, during drying, and in storage in Ghana. Peanut Science 47:72-80.

Arthur, S. 2020. Effect of Pest and Crop Management Packages in Groundnut - Based Cropping Systems on Agricultural Productivity. Presentation at the Peanut Innovation Lab Graduate Student Conference (Virtual).

Arthur, S. 2020. Effect of pest and crop management packages in groundnut-based cropping systems on agricultural productivity. Presentation at 2nd Ghana Groundnut Working Group (GGWG) Meeting, Tamale, Ghana.

Arthur, S. 2020. Financial Returns for Weed and Disease Management Inputs in Peanuts in Southern Ghana. Presentation at the 52nd American Peanut Research and Education Society Meeting (Virtual).

Darko, C. 2020. Aflatoxin issues and food safety concerns with groundnut. Presentation at 2nd Ghana Groundnut Working Group (GGWG) Meeting, Tamale, Ghana.

Dzomeku, I. 2020. The relevance of peanut (Arachis hypogaea L.) production in farming systems. Presentation at 2nd Ghana Groundnut Working Group (GGWG) Meeting, Tamale, Ghana.

Jordan, D. 2020. Development and delivery of improved production and pest management packages to peanut farmers in Ghana. Presentation at the Peanut Innovation Lab Annual Research Meeting, 2-4 June 2020 (Virtual).

Jordan, D. L. & Brandenburg, R. 2019. Value of international projects to faculty in the United States: Examples of participation by individuals at North Carolina State University with the Peanut Innovation Lab. Presentation at the 51st American Peanut Research and Education Society Conference, Auburn, AL USA.

Mochiah, B. 2019. Summary of interventions to minimize aflatoxin contamination in Ghana at pre-harvest and post-harvest steps in the supply chain. Presentation at the American Peanut Research and Education Society Conference, Auburn, AL USA.

Owusu-Akyaw, M., Mochiah, M. B., Osei, A. K., Ibrahim, A., Arku, G. B., Lamptey, J. N. L., Danyi, A. A., Oppong, A., Addo, J. K., Boateng, M. K., Adu-Dapaah, H. K., Addy, S., Amoah, S., Osei-Yeboah, S., Abudulai, M., Denwar, N., Naab, J., Mahama, G., Akroma, R., Brandenburg, R. L., Bailey, J. E., Jordan, D. L., Williams, T. H., Hoisington, D. & Rhoads, J. 2019. Evaluation and release of two peanut cultivars: a case study of partnerships in Ghana. Peanut Science 46: 37-41.

Seidu, A. 2020. Improved production and pest management packages for enhanced peanut (Arachis hypogaea L.) production and quality. Presentation at 2nd Ghana Groundnut Working Group (GGWG) Meeting, Tamale, Ghana.

Project B5. Satellite image analysis for peanut

Research Locations

LUANAR & Horizon Farms, Malawi; Stanford University, Stanford, CA, USA

Description

This project assesses the potential for using satellite imagery to determine several important cropping components for peanuts in smallholder farms. The information gained from satellite imaging could ultimately be linked with the decision risk tools to improve decision-making and the deployment of actions to maximize yields and minimize aflatoxin contamination. GPS field coordinates, along with yield and crop quality data from several hundred smallholder farms, will be submitted annually to collaborators at Stanford University for analysis of satellite images to estimate plant responses to achieve the project's objective of assessing the potential benefit of using satellite imagery.

Theory of Change/Impact Pathway(s)

If remote sensing data is proven accurate enough to detect various crops and their health and potential yield, it may offer a wide array of applications, including crop-forecasting estimates, index insurance, impact analysis of programs, etc.

Collaborators

Rick Brandenburg (PI), David Jordan and Dominic Reisig, North Carolina State University, Raleigh, NC; David Lobell, Stanford University, Stanford, CA; Jeremy Venable, Malawi Agricultural Diversification Activity, Lilongwe, Malawi; Wezi Mhango, Lilongwe University of Agriculture and Natural Resources, Lilongwe, Malawi; Andrew Goodman, Horizon Farms, Mitundu, Malawi

Achievements

Field data from private sector partners' 2019 trials were submitted to Stanford for analysis, though the quality of the data was not as high as was hoped, especially related to groundnut. The initial results indicate that it is possible to identify groundnut from the satellite images. Data from the 2019-20 season was collected and has been forwarded to Stanford for analysis.

Capacity Building

Additional training and iterative feedback on the data collection protocol was undertaken to improve the likelihood of better data for the 2020 crop.

Lessons Learned

Private sector partners may not be properly incentivized to follow research protocols if there is no clear benefit to them. Each partner is different in their internal processes which can lead to variable participation and compliance.

Presentations and Publications

None to report in this period.

Project B6. Peanut production packages for Malawi

Research Locations

DARS-Chitedze Research Station, Chitedze, Malawi; LUANAR, Mitundu, Malawi; Horizon Farms, Mitundu, Malawi

Description

This project develops profitable and sustainable peanut production practices that combine inputs and interventions to increase yield, quality and profitability for smallholder and more commercial farmers. This project will develop packages of proven technologies and evaluate them across recently released cultivars.
Specific objectives of the project are to: 1) develop production packages that optimize smallholder farmer productivity, quality and profitability; 2) publish and disseminate a production and management guide for peanut production in Malawi and surrounding countries; and 3) build capacity in Malawi through the training of MSc students and conducting training workshops in peanut production.

Theory of Change/Impact Pathway(s)

Adoption of technologies that improve peanut production is limited because farmers lack access to inputs, such as improved varieties, but also are not aware of costs and benefits of technologies that are presented as a package. This research will generate and share knowledge related the package-based approach that may help improve productivity.

Collaborators

Rick Brandenburg (PI), David Jordan and Dominic Reisig, North Carolina State University Raleigh, NC; Wezi Mhango, Lilongwe University of Agriculture and Natural Resources, Mitundu, Malawi; Jeremy Venable, Malawi Agricultural Diversification Activity, Lilongwe, Malawi; Andrew Goodman, Horizon Farms Ltd, Mitundu, Malawi; Justus Chintu, DARS, Malawi

Achievements

Field trials were on the DARS and Horizon Farms locations to evaluate the effects of fertilizer and inoculant on two groundnut varieties. While the results are from only a single season, the application of fertilizer was found to increase grain yield and biological nitrogen fixation, especially with the variety CG 9. The trials will be repeated in the next season.
An additional training and research planning meeting was arranged for the breeders in Malawi with colleagues at the South African Agriculture Research Council (ARC) Grain Crops Institute in Potchesfstroom. This research group focuses on groundnut in South Africa and has identified

a new nematode pest in groundnut in the region that may be seed borne and could cause germination problems that have been noted in Malawi. Arrangements were made to share germplasm with DARS, and the team visited commercial farms near the research station.

Capacity Building

An MS student was enrolled prior to the previous season and continues to engage with field trials and data analysis. The Malawi research team's visit to ARC was fruitful in making connections with another regional research center, especially for screening for the new groundnut nematode, but also was a good team-building exercise.

Lessons Learned

Additional funding and site visits in coordination with Malawi Agricultural Diversification Activity, the mission-funded research and development project, were helpful. Coordination and delineation of responsibilities and deliverables can be challenging due to the overlap and integration of some research goals and funding. Clear communication with all partners will be a priority in the coming year.
The connections with other regional research centers, such as the ARC groundnut team, should have been done earlier. The flexible additional funding and external network of US collaborators may sometimes assist with local and regional networking.

Presentations and Publications

Brandenburg, R. 2020. Development of efficient agronomic peanut production packages for Malawian farmers. Presentation at the Peanut Innovation Lab Annual Research Meeting, 2-4 June 2020 (Virtual).

Brandenburg, R. 2020. Examining the utility of satellite-based assessments in a maize/peanut agroecosystem for estimated crop response in Malawi. Presentation at the Peanut Innovation Lab Annual Research Meeting, 2-4 June 2020 (Virtual).

Chalwe, H. M., Lung, O. I., Mweetwa, A. M., Phiri, E., Njoroge, S. M. C., Brandenburg, R. L. & Jordan, D. L. 2019. Effects of compost manure on soil microbial respiration, plant-available-water, peanut (Arachis hypogaea L.) yield and pre-harvest aflatoxin contamination. Peanut Science, 46: 42-49.

Chalwe, H. M., Lungu, O. I., Mweetwa, A. M., Phir, E., Yengwe, J., Njoroge, S. C. & Brandenburg, R. 2020. The effects of gypsum on pod-yield and pre-harvest aflatoxin contamination in selected peanut cultivars of Zambia. African Journal of Plant Science 14(3): 134-138.

Chalwe, H. M., Lungu, O. I., Mweetwa, A. M., Phir, E., Yengwe, J., Njoroge, S. M. C., Brandenburg, R. L. & Jordan, D. 2019. Predicting aflatoxin content in peanuts using ambient temperature, soil temperature and soil moisture content during pod development. African Journal of Plant Science 13(3): 59-69.

Chalwe, H. M., Ngulube, M., Njoroge, S. M. C., Mweetwa, A. M., Lungu, O. I., Phiri, E. B. & Brandenburg, R. L. 2019. The role of manual sorting of raw peanuts to minimize exposure to aflatoxin-contaminated peanuts. Journal of Postharvest Technology 7(3): 80-86.

Mtengezo, P. 2020. Peanut production packages for Malawi: Response of groundnuts to rhizobia seed inoculation, inorganic fertilizer application and plant density. Presentation at the Peanut Innovation Lab Graduate Student Conference (Virtual).

C. Nutrition Research Project Reports

Project C1. Regulation of gut microbiome by peanut supplements in youth

Research Locations

Makerere University, Kampala, Uganda; University of Georgia, Athens, GA, USA

Description

This project studies the specific role peanuts play in improving nutrition and health in growing children by regulating their gut microbiota through a peanut snack provided to 6- to 9-year-old boarding school children of both genders in Mukono district in Uganda. We will use the next-generation sequencing and high-throughput analytical techniques to perform metagenomics and metabolomics analysis to assess the regulatory effects of peanut consumption on the structure and function of gut microbiome in healthy children. Preliminary analysis of both urine and stool samples will be conducted in Makerere University's College of Health Sciences, while advanced genomic and metabolomics analysis will be done at the University of Georgia in the US.
A baseline cross-sectional survey will be conducted in two primary schools to assess the household characteristics as well as nutritional and health status of the children. One of the schools will be randomized as the control and the other as the intervention. Over 90 days, one group of 48 students will receive salted peanuts, while 48 students will not receive peanuts. Growth parameters, such as weight and height, will be measured every 15 days. Fecal and urine samples will be collected at the same time for microbiome and metabolomics analysis. The research will explore the significant difference on growth parameters between children who regularly consume peanut snacks and those children who rarely consume peanut/peanut-based meals, as well as variations on peanut effects between males and females based on microbiome and metabolomics outcomes.

Theory of Change/Impact Pathway(s)

Increased understanding of the impact of peanut consumption on growth parameters the gut microbiome may increase peanut consumption.

Collaborators

JS Wang (PI), Lili Tang and Kathy Xue, University of Georgia, Athens, GA; John Ssempembwa and Geofrey Musinguzi, Makerere University, Kampala, Uganda

Achievements

The IRB documentation was submitted to Makerere University's IRB committee which approved the application in 2020. Two public schools near Kampala were identified, visited in early 2020, and agreed to participate in the study. With the closure of schools due to COVID-19, the study has not been able to go forward. Plans are being discussed to use a community-based study since it is not clear when schools will be reopened.
Originally, it was agreed that the peanuts to be used in the trials will be roasted, lightly salted nuts from the US so that quality assurance documentation will be available including aflatoxin

levels that meet Uganda standards. Given the delays and continue COVID-19 restrictions, the project decided to use locally produced peanuts that will be roasted and packaged in Kampala. While the study was to start in May 2020, it has been postponed due to COVID-19 restrictions in the country. The plan is to start the trials in late 2020/early 2021.

Capacity Building

Small equipment for anthropometric measurements and training for preliminary health exams and sampling are being provided to Makerere partners by the UGA PI and co-PIs.

Lessons Learned

Purchasing bulk roasted peanuts is best for such trials. The peanuts are high quality, fresh and sealed to maintain freshness for a long period of time. Shipment is best by air to minimize time in transit.

Presentations and Publications

Wangia, R. N., Githanga, D. P., Wang, J. & Anzala, O. A. 2019. Aflatoxin exposure in children age 6-12 years: a study protocol of a randomized comparative cross-sectional study in Kenya, East Africa. Pilot and Feasibility Studies 5:141-149. doi:http://creativecommons.org/license/by/4.0/.

Wangia, R. N., Ombaka, J., Dick, C. P., Strickland, C., Tang, L., Xue, K. S. & Wang, J. 2019. Aflatoxin in household maize for human consumption in Kenya, East Africa. Food Additives & Contaminants: Part B 13(1): 45-51. doi:1939-3229.

Zhou, J., Tang, L., Shen, C.-L. & Wang, J.-S. 2020. Green tea polyphenols boost gut-microbiota-dependent mitochondrial TCA and urea cycles in Sprague–Dawley rats. Journal of Nutritional Biochemistry 81: 1-10. doi:10.1016/j.nutbio.2020.108395.

Project C2. Integrating the power of peanuts into school feeding

Research Locations

University of Ghana, Accra, Ghana; Project Peanut Butter, Kumasi, Ghana; Washington University in St. Louis School of Medicine, St. Louis, MO

Description

School-aged children in Ghana receive largely starchy cereals for their sporadic school meals. A nutritious school meal would likely promote better growth and school performance. This project will develop a cost effective, peanut-based school food for distribution in Ghana and sub-Saharan Africa. Multiple food types, such as pastes, bars and whole peanut options will be considered in developing the final product. The project will then conduct clinical trials in Ghana to determine the effects of product consumption on growth and cognitive learning in young people. The results will help determine whether the power of the peanut, which has been such a game-changer in other food-aid products, can be channeled to school-age children as well.

Theory of Change/Impact Pathway(s)

Evidence of positive impacts of consuming peanut-based foods may lead to additional markets and increased demand for locally-sourced peanuts.

Collaborators

Mark Manary (PI), Reginald Lee, and Donna Wegner, Washington University in St Louis School of Medicine, St. Louis, MO; Matilda Steiner-Asiedu, University of Ghana, Accra, Ghana

Achievements

During this reporting period, several school food recipes were chosen after undergoing sensory evaluation trials and optimization for processing and organoleptic characteristics. This includes three different flavors with six paste-based and one biscuit recipes selected for the acceptability trial. Nutrient and safety tests with an outside vendor as required for FDA approval are encouraging. Samples and necessary paperwork were submitted to the Ghana FDA and received approval in April 2020. All necessary paperwork was then submitted to the University of Ghana IRB after receipt of FDA approval, and all necessary paperwork to WUSTL IRB is ready once the University of Ghana IRB approval is received. This includes an expanded age range of 6 to 12 years old to include adolescent girls. Data collection tools and an acceptability protocol have been created. Test batches of all six paste-based foods have been made for an acceptability trial that will be conducted in a community setting. The collaborators at the University of Ghana have identified five potential schools in Mion District willing to participate in the clinical trial, as well as acceptability testing. Mion District in one targeted by USAID Feed the Future for food security work in northern Ghana. It is also the location of previous successful legume project by this study team.

Ingredient	School food ready-to-use SFRU	School food ready-to-use plus SFRU+
Peanut, g (%)	36.7 (46%)	28.7 (36%)
Palm oil, g (%)	10.3 (13%)	10.3 (13%)
Sugar, g (%)	9.1 (11%)	9.1 (11%)
Maize, g (%)	8.0 (10%)	-
Cowpea, g (%)	14.9 (19%)	8.0 (10%)
Milk, g (%)	-	22.9 (27%)
Micronutrients, g (%)	1 (1%)	1 (1%)

Capacity Building

WUSTL continues to collaborate with the University of Ghana and Project Peanut Butter in partnership for this work.

Lessons Learned

FDA approval is necessary for acceptability trials, as well as for full clinical trials. This caused some delays in the process, but researchers worked through them as quickly as possible and still are on target to meet activity timelines.
In addition, the team expected to use a food scientist sponsored mostly on another grant. Since this grant was not funded, the team consulted with Partners for Food Solutions and another scientist, Thaddaeus May, in the creation of the nonpaste-based recipes. This has allowed the team to produce lab-based products that might be scaled for larger production if the same ingredients are available.

Presentations and Publications

Manary, M. 2020. Integrating the power of peanuts into school feeding. Presentation at the Peanut Innovation Lab Annual Research Meeting, 2-4 June 2020 (Virtual).

D. Gender and Youth Research Projects Reports

Project D1. Retaining the next generation of Senegalese farmers

Research Locations

Virginia Tech, Blacksburg, VA, USA; University of Georgia, Athens, GA, USA; University of Thiès/ENSA, Thiès, Senegal

Description

This project explores climatic and land-tenure constraints to youth participation in the Senegalese groundnut sector. Despite the strong historic emphasis on groundnut production in central and western Senegal, the sector has been stagnant in recent years as climatic variability and uncertainty in policies have generated a risky production environment. This production environment has also reduced incentives for young adults to enter into groundnut production, leading to high levels of rural out-migration, and threatening the long-run viability of peanut production.

Secondary household survey data, historic climate data, and a primary survey of 1,125 households in the groundnut basin will be used to quantify the economic costs of highly variable production environments and uncertain land-tenure arrangements for young groundnut farmers. The results of these analyses, in conjunction with workshops held with local community groups and farmer organizations, will be used to evaluate the feasibility of technology and policy options to address constraints.

Theory of Change/Impact Pathway(s)

Youth participation is a key to the future viability of the Senegalese groundnut sector. Young people will choose to enter (or remain in) groundnut farming if the sector contributes to a viable livelihood strategy. This project will provide insights regarding the best technical and policy options for reducing risks to production and land tenure, which if adopted by development actors, will improve the viability of groundnut production as a household livelihood strategy for the next generation of Senegalese farmers.

Collaborators

Bradford Mills (PI), Virginia Tech, Blacksburg, VA; Genti Kostandini, University of Georgia, Griffin, GA; Pierre Maurice Diatta, Consultant, Senegal; Katim Toure, ENSA, Senegal; Tamsir Mbaye, ISRA, Senegal

Achievements

A population weighted sample of 75 villages was drawn (along with 10 backup villages) from the provinces of Kaolack and Kaffrine and the department of Koumpentoum within the province of Tambacounda with less than 900 persons in the last census. Mills, Toure, Mbaye, and Diatta drafted a household survey and survey protocols in French. Sixteen tablets were programmed with CSPro for data entry. Survey pre-testing, data entry program testing, and contacting of villages was undertaken between January 28 and February 11. The survey was implemented between February 12 and March 10. Household heads and a randomly selected youth between 16 and 29 years of age were interviewed in 1,125 households. Further, all household groundnut

fields (approximately 4,000) were measured by GPS. Areas and plot maps of each household were saved. Data cleaning activities are currently underway, and 1,123 households have been properly identified. Key findings are:

- Outmigration of young adults to other areas in Senegal is an important livelihood strategy – engaged in by 38 percent of male young adults and 10 percent of female young adults.
- However, the majority of young adult out-migrants (79 of males and 65 percent of females) continue to be involved in household groundnut production activities during the cropping season.

Senegalese climate data from 1998 to 2019 on daily rainfall, temperature, and weekly standardized precipitation index (SPI), and weekly normalized digital vegetative index (NDVI) was downloaded. These variables are being used to characterize the geographic distribution of climatic variability for each department in the Groundnut Basin. In addition, information was extracted from the 2011 Enquete de suivi de la pauvrete au Senegal (ESPS), a nationally representative survey of 5,941 households, on peanut production, household food expenditures, demographics, and poverty incidence for each department in the Groundnut Basin. We have also extracted information from rounds 2011 and 2017 of the Demographic and Health Survey (DHS) on youths' (by gender) agricultural land ownership, education, land titles, and birth certificates for each department in the Groundnut Basin. The three datasets will be used to identify sources of risk and their variation. The last dataset that we are working with is the 2018 Enquête de Recertification du Registre National Unique (RNU), which contains information on land title and household expenditure. Initial key findings are:

- Young females are less likely to own land than young males;
- Females (for children up to 6 in 2011) are less likely than males to have a birth certificate;
- Droughts significantly decrease the male to female ratio in rural areas; and
- Extreme temperature spells decrease population in rural areas.

Capacity Building

A student was selected for MS training at Virginia Tech in Agricultural and Applied Economics but will not be able to travel to the US until 2021 due to COVID-19 restrictions. Two other students were selected for MS scholarship support to work on youth in agriculture thesis topics at ENSA in Senegal. Project PI Bradford Mills and Senegal-based project co-PIs Katim Toure, Pierre Diatta, and Tamsir Mbaye trained four supervisors and 16 interviewers to conduct a survey of 1,125 households in the provinces of Kaolack and Kaffrine and the department of Koumpentoum within the province of Tambacounda.

Lessons Learned

Issues were encountered with CSPro tablet programming that delayed survey implementation and timely verification of household data. Increased programming capacity will be incorporated into future survey activities. Data cleaning was delayed due to COVID-19 but is progressing.

Presentations and Publications

Mills, B. 2020. Retaining next generation farmers in the Senegalese groundnut basin. Presentation at the Peanut Innovation Lab Annual Research Meeting, 2-4 June 2020 (Virtual).

Mills, B., Touré, K., Mbaye, T., Diatta, P. & Kostandini, G. 2019. Retaining next generation farmers in the Senegalese groundnut basin. Presentation at the Peanut Innovation Lab Senegal Project Launch Workshop, Dakar, Senegal.

Project D2. Farmer Incentives for quality Ghanaian peanuts

Research Locations

University of Development Studies, Tamale, Ghana; Project Peanut Butter, Kumasi, Ghana; AMSIG, Tamale, Ghana; University of Georgia, Athens, GA

Description

Groundnut value chains in Ghana are long and fragmented, consisting of many smallholder producers and intermediate traders. In this market environment, the farmer may not receive incentives to grow high quality and safe food, and the produce available at the market is generally low quality and at risk of aflatoxin contamination. Consequently, demand for aflatoxin-safe groundnuts is mostly fulfilled by imports even though Ghana is the 10th largest groundnut producing country in the world. Efforts to link smallholder groundnut farmers to high value markets in Ghana rely on an aggregator model, wherein aggregators provide services or inputs to farmers at the beginning of a season, and subsequently purchase their production to sell to downstream buyers. This model has potential but, for a number of reasons, aggregators are challenged in their ability to accumulate safe, adequate groundnut supplies.

This project aims to strengthen value chain linkages by helping aggregators provide yield-enhancing and aflatoxin-reducing inputs to farmers. The impact of offering these input packages will be evaluated using a randomized control trial at the village level. Outcomes of interest include uptake of inputs on credit, quantity of groundnuts sold to the aggregator, quantity of groundnuts kept for home consumption, and groundnut aflatoxin levels. The project will include analysis of gender-specific differences in all outcomes and what may have caused those differences.

Theory of Change/Impact Pathway(s)

By gauging how farmers accept inputs on credit, how much they sell to the aggregator, how much they keep for home consumption, and groundnut aflatoxin levels, the study will serve as a proof of concept to downstream premium buyers, NGOs, or government agencies seeking to enhance smallholders' participation in premium value chains. The study will also provide insights about ways to improve gender inclusivity in groundnut market and value chain interventions.

Collaborators

Nicholas Magnan (PI) and Ellen McCullough, University of Georgia, Athens, GA; Vivian Hoffmann, International Food Policy Research Institute (IFPRI), Nairobi, Kenya; Nelson Opoku, University for Development Studies (UDS), Tamale, Ghana

Achievements

The team worked to identify and build relationships with several premium processors and aggregators of groundnut, and continued efforts to link at least one aggregator and processor together in a formalized contractual arrangement. An agreement was drafted with AMSIG (an

aggregator) to provide post-harvest training and tarps to 120 farmers, which was calculated to result in 15-20 metric tons of low aflatoxin groundnuts to be purchased by Project Peanut Butter (a premium processor). Although training and tarp distribution began, the deal ultimately fell through on both ends.

A new aggregator, Sumalia Doho, in Upper West was identified who works with the GIZ Market Oriented Agriculture Programme (MOAP) project. Sumalia gets input support for his farmers from MOAP, making him a very promising partner. The project supplied 800 of his farmers with 1000 tarps, with the goal of producing 100 MT of low-aflatoxin groundnuts for purchase by Project Peanut Butter (PPB) in Kumasi. Project Peanut Butter has agreed in principle to buy these groundnuts conditional on quality and aflatoxin levels. The team anticipated conducting the first buying/selling of this season's crop in November 2020.

PI Nick Magnan and a US-based PhD student traveled to Ghana in January to meet with potential buyers. Focus groups (including discussions about contracts and improved seeds) were conducted with approximately 50 farmers (25 female, 25 male). Members of the project team also attended the 2nd Ghana Groundnut Working Group (GGWG) meeting in Tamale in March, which resulted in deeper relationships between our project and actors working in this sector.

Capacity Building

We have provided 800 farmers working with Doho with tarps and trained them on drying practices. Two UDS students have gained experience working with farmers and aggregators and are learning about the various complications along the groundnut value chain.

Lessons Learned

There is extremely little trust in the value chains between farmers and aggregators and between aggregators and processors. We have seen examples of why, with aggregators not doing their best to fulfill even a small contract and processors rescinding an agreed-upon price due to funding issues. We knew this would be difficult but underestimated the extent.

The market for premium groundnuts is very thin and sporadic. We searched extensively for premium groundnut processors and contacted each of them several times with the goal of connecting them to a project aggregator. None of them, except Project Peanut Butter, were interested.

Presentations and Publications

Magnan, N. 2020. Connecting male and female smallholder farmers to premium groundnut markets and aflatoxin-mitigating technologies through innovative aggregator contracts. Presentation at the Peanut Innovation Lab Annual Research Meeting, 2-4 June 2020 (Virtual).

Magnan, N., Hofmann, V., Gajate Garrido, G., Kanyam, D. & Opoku, N. 2019. Information, technology, and market rewards: Incentivizing aflatoxin control in Ghana. IFPRI Discussion Paper No. 1878.

Posey, S. 2020. Observing Intra-Household Information Sharing Using a Lab in the Field Experiment in Northern Ghana. Presentation at the Peanut Innovation Lab Graduate Student Conference (Virtual).

Project D3. Time poverty among women smallholders in Ghana: Implications for gender priorities in the peanut value chain

Research Locations

CSIR-SARI, Tamale, Ghana; Pennsylvania State University, Reading and University Park, PA, USA

Description

Groundnut is a labor-intensive crop, with time constraints at critical points in production. Women are the primary producers and processors of groundnut in Ghana, but their engagement and productivity are limited by traditionally gendered roles and responsibilities. This project investigates time poverty (defined as insufficient time to take on new tasks and responsibilities) and its influence on women's participation in the groundnut value chain. The project will survey men and women's time use at various stages of the production cycle to expand the understanding of time poverty in relation to the groundnut sector. After conducting an inventory of locally-available time-saving and time-enhancing technologies, these technologies will be disseminated through gender-integrated farmer field schools and evaluated for their capacity to enhance women's participation in groundnut production.

Enumerators were able to conduct the first survey over the phone allowing work to go ahead despite the Covid-19 pandemic.

Theory of Change/Impact Pathway(s)

A better understanding of the differences between men's and women's roles in groundnut production is necessary to develop appropriate interventions. The study will inform efforts to improve technology adoption amongst smallholder groundnut farmers and assist practitioners in selecting interventions that reduce women's time poverty and enhance women's ability to engage in peanut production.

Collaborators

Leland Glenna (PI), Paige Castellanos and Leif Jensen, Pennsylvania State University, University Park, PA; Janelle B. Larson, Pennsylvania State University Berks, Reading, PA; Edward Martey, Doris Kavenaa Puozaa and Richard Oteng-Frimpong, CSIR-Savanna Agricultural Research Institute, Nyankpala, Ghana

Achievements

Two survey instruments were merged and revised to be used to measure men and women's time use, engagement in the peanut value chain, and later, changes to time use, engagement, and other measures of household well-being that may result from the introduction of labor enhancing and

labor-saving technologies. To measure women's time poverty in relation to men's time poverty the abbreviated women's empowerment index in agriculture (A-WEIA) survey is being used. However, it was modified to incorporate the fact that many of the households in the study area practice polygamy. Therefore, questions were revised to ask specifically about which tasks are assigned to different wives in the household. Since it is important to understand women's time poverty in the context of agricultural production in Northern Ghana, an existing survey was modified to document crop production, food preparation, and market activities in Northern Ghana. The survey was shortened, because it typically took 3 hours to complete. It can now be completed in approximately 1 hour. Questions were also revised to better address the topics that are targeted in this project (e.g. time poverty, technology adoption, and market, consumption and production behavior associated with peanut agriculture).

Despite the pandemic, the team completed the first wave of the survey in June of 2020. That survey covered issues of time poverty during the dry season. We conducted the survey by phone because the pandemic prohibited us from meeting people in person. We will complete a second wave of the survey, which will cover time poverty during the planting season.

Capacity Building

The project will support three graduate students in Ghana.

Lessons Learned

The project has had challenges getting students admitted to Penn State. Some African students do not do well on standardized tests, including the TOEFL and the GRE. This (as well as the coronavirus pandemic) made it necessary to educate students in Ghana, rather than bringing them to the US.

Pandemic requires creative innovation to conduct research while keeping everyone safe. To accommodate travel restrictions and social distancing, the team in Ghana piloted a successful system of telephone surveys, allowing enumerators in a different location to question participants, while a local extension agent wearing PPE verified that the correct person responded and under the correct circumstances. Wives, for example, many answer more accurately if they are surveyed alone, rather than in the presence of a husband.

Presentations and Publications

Fischer, K. 2020. Gendered Time Poverty and Empowerment among Peanut Producers in Northern Ghana: Baseline Findings. Presentation at the Peanut Innovation Lab Graduate Student Conference (Virtual).

Glenna, L. 2020. Time poverty among women smallholders in Ghana: Implications for gender priorities in the peanut value chain. Presentation at the Peanut Innovation Lab Annual Research Meeting, 2-4 June 2020 (Virtual).

Project D4. Photovoice for Ugandan youth empowerment

Research Locations

Makerere University, Kampala, Uganda; NARO-NaSARRI, Soroti, Uganda; University of Tennessee, Knoxville, TN, USA

Description

Youth participation in farming is critical for the future of Ugandan groundnut production, yet avenues for fostering youth engagement remain unclear. This project uses photovoice – a participatory visual research methodology – to compare the experiences of young men and women living in rural, groundnut-producing communities of Northern and Eastern Uganda, and to investigate the factors that empower and enable youth to be active stakeholders in the groundnut value chain. The study will also evaluate the use of photovoice itself as a tool for empowerment. Thirty youth will be trained in photovoice and will subsequently collect photos using smartphones over the course of two groundnut production seasons, select photos, explain their photo-stories, and then participate in focus group discussions to further articulate their actual and ideal engagement in groundnut value chains. The findings will be disseminated through community festivals, oral presentations, written reports, workshops, and a digital platform to host a repository of visuals of youth empowerment in peanut value chains.

Theory of Change/Impact Pathway(s)

The results of this study will help practitioners to design agricultural policies and interventions that reflect youth aspirations and reduce the barriers to their engagement in Ugandan groundnut production. The project will also produce best practices for using photovoice as a method for understanding and empowering rural, Ugandan youth, which can be adopted by practitioners in their own future work.

Collaborators

Carrie Ann Stephens (PI), Dave Ader, Tom Gill and Jennifer Richards, University of Tennessee, Knoxville, TN; Archileo Kaaya, May Sengendo and Stephen Lwasa, Makerere University, Uganda; David Okello Kalule, NARO-NaSARRI, Uganda

Achievements

Thirty smart phones and tablets were purchased for the purpose of collecting photovoice data. The phones were purchased in Uganda so that they will be compatible with Ugandan youth preferences.
A US-based graduate student at the University of Tennessee developed a training manual for the project, including photovoice training and guidance, guides for taking excellent photos, and confidentiality and ethics considerations.
University of Tennessee IRB approval was secured to conduct the interviews, focus groups, photovoice analysis, etc.

Capacity Building

The fieldwork launch was rescheduled for late April, and then the pandemic occurred.
Two MS students were enrolled at Makerere and are working with project co-PIs to develop their research proposals, which will incorporate the photovoice methodology and relevant data collected through the project.
Members of the team participated in the gender workshop organized by the GREAT team.

Lessons Learned

Sub-award funds need to be available to Uganda university faculty and students immediately. A reimbursable contract is not well-suited to the needs of our international partners, who do not have funds available to be spent first and then reimbursed. This is also the case with graduate

student tuition and fees. As a result of the delays in the sub-award process and funds transfer, project activities (particularly getting our youth participants trained in photovoice) were delayed and our local partners did not have the funds to operate the program as planned.

Presentations and Publications

Sengendo, M. & Kaaya, A. 2019. Photovoice for empowering youth through the peanut value chain in two sub-counties of Busoga region, Uganda. Presentation at Makerere University, Kampala, Uganda.

Stephens, C. 2020. Photovoice for youth empowerment in peanut value chains in Uganda. Presentation at the Peanut Innovation Lab Annual Research Meeting, 2-4 June 2020 (Virtual).

Project D5. Gender dynamics in Senegalese peanut production

Research Locations

University of California, Santa Barbara, CA, USA; Université de Gaston Berger, Saint-Louis, Senegal; CRDES, Dakar, Senegal

Description

Achieving gender equality in agricultural development is fundamental to reduce global poverty, hunger and malnutrition. Women's participation in Senegalese groundnut farming is embedded in social context and linked to the work and needs of others in the household and community. Although women play a critical role in groundnut production, their efforts may be impacted by inefficient and inequitable allocations of labor and resources with respect to complex household structures and concomitant intra- and inter-household gendered power dynamics. Existing research is lacking in terms of providing an adequate description of these interconnections, as well as the ways in which they mediate the impacts of stressful events.

This project researches how men and women's engagement in various aspects of groundnut production in Senegal is influenced by intra-household structure and gendered power dynamics, and how those relationships are further impacted by stressors including 1) the initiation, timing, and spacing of births; and 2) concurrent climate shocks (precipitation and temperature). Traditional time-use study methods have significant limitations in low-literacy, low-resource populations like those of rural farmers in Senegal. The project is developing an innovative method for measuring time use employing wrist-worn technologies (activity monitors and recorders) to periodically signal participants to record audio clips of their activities. This method has several potential advantages over traditional approaches including minimized participant burden, increased granularity, decreased seasonality effects, more specific coding and analysis, and less required resources.

Theory of Change/Impact Pathway(s)

A better understanding of the differences between men's and women's roles in groundnut production is necessary to develop appropriate interventions. The research takes a complex systems approach to understanding the lives and livelihoods of male and female groundnut farmers. The results will inform the development of multi-sectoral strategies (involving e.g. agriculture, health, environment and education) to improve the resilience and gender inclusivity of groundnut production in rural Senegal. While time-saving technologies have been proposed as a solution to time poverty in this region, they may be ineffectual if implemented without an understanding of the power dynamics that keep women working in limited roles and for many

hours. Analyses of farmer responses to weather shocks can be used to understand resilience, and model production outcomes under future climate scenarios. Monitoring time use during both the dry and rainy season will provide a more detailed understanding of how men and women's time-use varies at different times of the year, which practitioners can use to refine the timing of their interventions.
Finally, the innovative wrist-worn technology and associated protocols developed through the project will be of significant benefit to other researchers seeking to understand time use and activities in similar contexts.

Collaborators

Stuart Sweeney (PI) Kathy Baylis, and Sari Blakeley, University of California, Santa Barbara, CA; Jacqueline Banks, University of Minnesota, Minneapolis, MN; Samba Mbaye and Mamadou Ba, CRDES, Senegal

Achievements

After modifications to ensure contactless research per UCSB pandemic requirements, the pilot study resumed and 23 students have completed the protocol to date. The data collection is on-going and capturing a unique time among university students: coping with shared living environments and COVID-19 restrictions. This research has been expanded to collect at least 35 participants. Data collection will continue through fall, and after data collection is completed, analysis for a publication based on this data will start.

An ethnographic assessment was conducted in February and March, just before Covid-19 travel restrictions went into effect.

In late February to early March, Jacqueline Banks and Jessica Marter-Kenyon conducted a rapid ethnographic assessment with support from two graduate students in Senegal. The team is currently working together to write a paper on the rapid ethnographic study's results, with the students as co-authors. The students have become affiliates of the University of California, Santa Barbara, which is expected to facilitate gaining an IRB for our planned research in Senegal.

The research in Senegal is currently still stalled due to COVID-19. The financial partnership between UCSB and CRDES is nearly completed, but a Human Subjects approved protocol must still be established. To this end, our team is working with the IRB office at UCSB to find a means to include our Senegalese collaborators in the protocol. Additionally, research in Senegal cannot take place until UCSB establishes a procedure for international human subjects research. This is expected to happen before the end of the year (2020). Methodology has been in

development among Stuart Sweeney, Kathy Baylis, Sari Blakeley, and Sophia Arabadjis, focusing on ensuring a safe data collection process.

Capacity Building

The UCSB team is collaborating directly with the Senegalese students on the team to develop research questions appropriate for their theses and in line with the research for the overall project. Additionally, the Senegalese students are actively involved in writing a paper based on the results from the rapid ethnographic assessment. New computers, improved home internet, and English classes are being provided for the Senegalese students to facilitate communication and research.

Lessons Learned

Putting in place financial partnerships with UCSB and other institutions is a process, which has different requirements at each step of the way, making the establishment of a partnership a long process, particularly when there are international regulations to follow. To continue our pilot research after the start of the COVID-19 pandemic, a process for distanced research was established and is currently used for collecting data. This process simultaneously requires more effort to keep the equipment clean and is more time-consuming to actually collect the data. However, developing this process has given us ideas for creating a similar process for the Senegal research.

Presentations and Publications

Arabadjis, S. & Sweeney, S. 2020. Gender, fertility, and intra-household dynamics and resilience in the Senegalese peanut product chain: Project Updates. Presentation at the Peanut Innovation Lab Graduate Student Conference (Virtual).

Arabadjis, S., Banks, J., Schlund, S., Blakeley, S. & Sweeney, S. 2020. New Methods in Time Use: Wrist-worn Technology. Presentation at the Population Association of America Conference, Washington, DC USA.

Arabadjis, S., Baylis, K. & Sweeney, S. 2020. WHAM! Pilot Study: Preliminary Results. Presentation at the Peanut Innovation Lab Graduate Student Conference (Virtual).

Banks, J., Marter-Kenyon, J., Ndiaye, C., Diop, M., Ba, M., Mbaye, S. & Sweeney, S. 2020. Understanding Intra and Inter Household Gendered Power Dynamics in the Division and Time Allocation of Work and Resources: Ethnographic Assessment of a Peanut Farming Population in Rural Senegal. Presentation at the American Association of Geographers Annual Meeting 2020 (Virtual).

Diop, M., Ndiaye, C., Ba, M., Mbaye, S., Banks, J., Marter-Kenyon, J. & Sweeney, S. 2020. Understanding Gender Dynamics in the Management of the Resources of the Household, Framework for the Development of the Agricultural Section in Rural Areas in Senegal. Presentation at the Peanut Innovation Lab Graduate Student Conference (Virtual).

Ndiaye, C. 2020. Gender Dynamics, Division of Labour Time and Credit for Peanut Producers in Rural Senegal. Presentation at the Peanut Innovation Lab Graduate Student Conference (Virtual).

Sweeney, S. 2020. Gender, fertility, and intra-household dynamics in the resilience of Senegalese peanut production. Presentation at the Peanut Innovation Lab Annual Research Meeting, 2-4 June 2020 (Virtual).

Associate Award Research Project Reports

While technically not an associate award, the Peanut Innovation Lab has received funding from the following two implementing partners of USAID mission projects.

AA1. Malawi Agricultural Diversification Activity, Palladium International, LLC (IP)

Project Description

The Malawi Agricultural Diversification Activity (AgDiv) contracted with the Peanut Innovation Lab to recommend best management practices to increase groundnut productivity, evaluate potential improved groundnut varieties, enhance seed production of released varieties, conduct household surveys to identify constraints to improved groundnut production, provide training on groundnut production, and conduct cost-benefit analyses of AgDiv-promoted technologies. Additional projects were developed during this fiscal year to evaluate the use of Aflasafe, improve grading and aflatoxin testing capacity, and to develop recipes and strategies to include peanuts in a pre-existing soy milk project.

Collaborators

Dave Hoisington and Jamie Rhoads, University of Georgia; Rick Brandenberg and David Jordan, North Carolina State University; Boris Bravo-Ureta, University of Connecticut; Frank Nolin, Frank's Designs for Peanuts; Greg MacDonald, University of Florida; Justus Chintu, DARS Chitedze Research Station; Limbikani Matumba, Aggrey Gama and Wezi Mhango, LUANAR; Andrew Goodman, Horizon Farms; Tadala Rambiki, Pyxus

Achievements

Field trials were conducted at Horizon Farms and DARS-Chitedze to refine an efficient production package for groundnut. One experiment studied the effect of plant density, variety, fertility and inoculant on yield. A second experiment investigated the effect of fungicide applications to control disease, and a third experiment studied the effect of pre- and post-emergence herbicide applications on weed control and yield. Given issues with germination and handling of the trials, the results were not conclusive and the trials repeated next year with better seed and trial management.

Field trials conducted by Pyxus on-station compared two planting densities and use of inoculant, fertilizer and gypsum. The first year results indicated that increasing plant density and use of fertilizer does increase yield, while the results for inoculant and gypsum were not significant. Researchers will repeat the trials for at least two more years.

Aflasafe was tried on more than 100 Pyxus farmer fields. By the end of the experiment, only around 40 trials were acceptable for data analysis. Data on aflatoxin contamination is being collected, but no yield difference was found between fields treated with Aflasafe and those left untreated.

Research partners evaluated a portable buying point system to determine if a sample from the grade-outs could be used to predict the aflatoxin concentration of the whole lot with better accuracy while keeping the destructive sample size small. Samples from farmer lots were shelled

and graded. Aflatoxin analysis indicated that the grade-out components were able to predict the level of aflatoxin contamination in the original sample. The grading system also indicated that current standards for quality peanuts are not an accurate reflection on the overall quality of the lot. Analysis will continue to find the most efficient way to determine the grade and quality of groundnuts that are purchased from farmers.

Capacity Building

In a December 2019 visit, Greg MacDonald and Jamie Rhoads trained Pyxus, Limbe Leaf, AfriOils, and DARS field technicians and scientists in peanut agronomy. Formal presentations and field visits allowed for detailed discussion on various aspects of early season peanut growth.

A second visit by David Jordan, Dave Hoisington and Jamie Rhoads in January 2020 provided further training to the local partners in mid-season issues and covered the best methods to determine crop maturity.

Trainees received the first version of the Malawi Groundnut Production Guide drafted by Rick Brandenburg and David Jordan. The guide will be updated each year based on the latest data on best management practices for groundnut.

Two graduate students at LUANAR received support under the Aflasafe and grading projects.

Lessons Learned

Private sector partners are very interested to partner and conduct field trials on their research stations and with their farmers. While this is a great opportunity to expand research activities, attention must be made to proper planning and management of the trials during the season and especially during harvest.

AA2. Bangladesh Rice and Diversified Crops Activity, ACDI/VOCA (IP)

Project Description

Bangladesh produces approximately 66,000 MT of peanuts (groundnuts) with yields averaging around 1.5 kg/ha. Peanuts are grown primarily by smallholder farmers, although there are some farmers cultivating larger acreage and/or assembled into cooperatives. The majority of peanut produced is used for internal processing and consumption. It is estimated that farmers are able to meet only 50% of the internal demand for quality peanuts. Given expected trends in the marketing and consumption of peanuts and peanut products, the demand is expected to rise, further reducing the ability of local farmers to meet the requirements. With the lack of additional land for cultivation, increases in peanut production will need to come from improved varieties and agronomic practices, while also working to reduce losses and preserve quality during post-harvest handling and storage.

The predominant variety, Dhaka-1, is a small-seeded, red-skinned Spanish peanut that was released many years ago. A few newer varieties (e.g., Chinabadam 8) are available that are larger seeded, possess resistance to the major diseases and are potentially higher yielding. Adoption of these varieties is limited, partly due to a lack of quality seed and a formal seed system for

scaling. There is a desire to have a larger-seeded, but early maturing (<120 days) variety that would be more adaptable to the current short growing season and meet market demands.

The ultimate goal is to enhance the production and processing of quality peanuts that meet the market demands in Bangladesh. The initial objective will be to increase the availability of improved varieties (short season, high oleic, large seed size) that meet market demands and increase productivity on-farm.

To accomplish this objective, new peanut varieties developed in the USA and potentially suitable for Bangladesh will be sent to the Bangladesh Agriculture Research Institute (BARI) and the private sector to conduct variety trials of these and improved locally-bred varieties. The varieties will be provided by Naveen Puppala, peanut breeder at New Mexico State University and Peanut Innovation Lab collaborator. Puppala's breeding program focuses on short duration Valencia, Virginia and Spanish market types, including high-oleic varieties, that are most likely to fit the local agronomic and market requirements. Puppala also has a long-term relationship with ICRISAT scientists currently working in Bangladesh and can help strengthen the linkages between the US and ongoing variety evaluation and development efforts.

Collaborators

Dave Hoisington and Jamie Rhoads, University of Georgia; Frank Nolin, Frank's Designs for Peanuts; Naveen Puppala, New Mexico State University, BARI Groundnut Program, Partex Ltd.

Achievements

Seed of 24 peanut varieties were sent to BARI, and 15 released varieties to Partex. These were planted in replicated trials. Due to COVID-19, proposed travel by the Peanut Innovation Lab team was not possible; however, the data from the varieties trials has been provided to Naveen Puppala for analysis. Based on the results, the best varieties will be planted in large trials.

Capacity Building

Due to COVID-19 restrictions, the planned travel and training was not possible. Hopefully, these could be rescheduled during 2021.

Lessons Learned

There is a strong desire to improve peanut production in the country, especially by the processors who see opportunities for local processing into products including oil.

Human and Institutional Capacity Development

Short-term Training (Workshops/Courses)

Country of Training	Title	Brief Purpose of Training	Who was Trained	Number Trained		
				M	F	Total
United States	Annual Research Meeting	Annual Research Meeting shares the findings and research plans of the 21 active projects in the Peanut Innovation Lab portfolio, providing an opportunity to learn about the various methodologies and identify opportunities for collaboration. Students especially benefit by both presenting their research and interacting with all scientists and students. Due to COVID-19, the meeting originally scheduled in Malawi was held virtually.	Scientists, Technicians, Students, and Researchers	80	51	131
United States	Peanut Innovation Lab Graduate Student Presentations I	The Feed the Future Peanut Innovation Lab held four Graduate Student Presentation events during the month of August. Due to the COVID-19 pandemic, the presentations were held virtually. With over 30 students participating, this provided students a wonderful opportunity to present about the research they are involved in and it also solicited feedback about both their research efforts and presentation overall.	Scientists, Technicians, Students, and Researchers	27	17	44
United States	Peanut Innovation Lab Graduate Student Presentations II	The Feed the Future Peanut Innovation Lab held Graduate Student Presentations during the month of August. Due to the COVID-19 pandemic, the presentations were held virtually. With over 30 students participating, this provided students a wonderful opportunity to present about the research they are involved in and it also solicited feedback about both their research efforts and presentation overall.	Scientists, Technicians, Students, and Researchers	21	22	43

Country of Training	Title	Brief Purpose of Training	Who was Trained	Number Trained		
				M	F	Total
Ghana	Workshop on the Use of Sensors for Phenotyping in Groundnut	During the visit of Maria Balota to CSIR-SARI in Tamale, Ghana, a training session was organized on the use of all the sensors acquired. The objective was to equip the participants with the needed skills to operate the sensors and interpret the resulting data. Training included the theory behind the operation of the sensors and the interpretation of the data that is obtained from their use. The training was attended by scientists, graduate students, technicians working at CSIR-SARI and the groundnut breeder from INERA, Burkina Faso.	Scientists, Technicians, Students, and Researchers	7	0	7
Ghana	2nd Ghana Groundnut Working Group Meeting (GGWG)	The goal of this activity was to develop a platform to increase interactions and cooperation among individuals and organizations involved in groundnut production in Ghana through formal presentations and discussion sessions.	Scientists, Technicians, Farmers, and Researchers	31	9	40
Kenya	Webinar: Catalyzing the use of aflatoxin control technologies in Kenya and Ghana	Webinar targeting policymakers and stakeholders in the maize and groundnut value chains in Kenya and Ghana	Scientists, Technicians, and Researchers	21	11	32
Senegal	Shrub Propagation Techniques and Optimized Shrub System Management	The objective of the workshop was to evaluate the 2019 trial implementation season in order to improve collaboration and better approach the second year. The workshop was organized in three plenary sessions including the opening ceremony, the session of presentations followed by discussions and the closing ceremony.	Scientists, Technicians, and Researchers	22	9	31
Senegal	Household Survey Implementation Training	The training focused on understanding the survey, use of CSPro program for data entry, and piloting of the survey.	Scientists, Technicians, Students, and Researchers	15	5	20

Country of Training	Title	Brief Purpose of Training	Who was Trained	Number Trained		
				M	F	Total
South Africa	Workshop with peanut scientists from ARC Grain Crops Institute in Potchefstroom, South Africa	One-day on-site wokrshop to discuss research findings of Malawi Peanut Innovation Lab team and ARC staff regarding peanut research. The participants also discussed and planned collaborative research focused on nematodes and germplasm exchange for 2020 and 2021.	Scientists, Technicians, and Researchers	14	8	22
Uganda	GREAT Gender Awareness Course	The course focused on strengthening the ability of the participants to design and conduct gender responsive groundnut research. It also helped to instill a positive attitude and value for gender responsive research.	Scientists, Technicians, and Researchers	13	17	30
Uganda	BMS Training Workshop	A two-day BMS training workshop was conducted at NaSARRI on 18-19 February 2020. The training was facilitated by Mrs. Mabel Mulanya from IBP. All staff members and students were in attendance with technicians from the CGIAR Cereals and Dryland Legumes Program. Participants were introduced to new BMS features such added flexibility in adding additional experimental locations even when data has been obtained for subsequent locations and data visualization using histogram in the most recent version of the BMS (Version 14.0).	Scientists, Technicians, and Researchers	15	5	20
Uganda	Training on Production of Quality Declared Seed	The one-day training focused on equipping extension workers and lead farmers in Quality Declared Seeds production of groundnut.	Scientists, Technicians, Farmers, and Researchers	8	3	11
Uganda	Groundnut Training for Local Seed Businesses	The purpose of the training was to: a) identify the different groundnuts varieties with their distinct attributes, b) elaborate on the key groundnut agronomic practices, and c) draw up a tentative production plan including booking of foundation seed.	Scientists, Technicians, and Researchers	20	27	47

Country of Training	Title	Brief Purpose of Training	Who was Trained	Number Trained		
				M	F	Total
Uganda	Training for World Vision sponsored farmers in Production of Quality Groundnuts Production and Seeds systems	Brief lecture on what happens in the NARO groundnuts unit. The issues of quality production using recommended Agricultural practices	Scientists, Technicians, Students, and Researchers	10	0	14
Uganda	Training for CIDI sponsored farmers in Production of Quality Groundnuts Production and Seeds systems	Quality Declared Seed Production	Scientists, Technicians, and Researchers	12	2	14
United States	Peanut Innovation Lab Graduate Student Presentations III	The Feed the Future Peanut Innovation Lab held Graduate Student Presentations during the month of August. Due to the COVID-19 pandemic, the presentations were held virtually. With over 30 students participating, this provided students a wonderful opportunity to present about the research they are involved in and it also solicited feedback about both their research efforts and presentation overall.	Scientists, Technicians, Students, and Researchers	18	19	37
United States	Peanut Innovation Lab Graduate Student Presentations IV	The Feed the Future Peanut Innovation Lab held Graduate Student Presentations during the month of August. Due to the COVID-19 pandemic, the presentations were held virtually. With over 30 students participating, this provided students a wonderful opportunity to present about the research they are involved in and it also solicited feedback about both their research efforts and presentation overall.	Scientists, Technicians, Students, and Researchers	23	22	45
United States	Participation in American Peanut Research and Education Society Virtual Annual Meeting	Participate in virtual conference and view/listen to presentations from a wide variety of peanut scientists from around the world	Scientists, Technicians, Students, and Researchers	4	1	5

Long-term Training

Trainee Number	Gender	University	Degree	Major	Program End Date (month/year)	Degree Granted	Home Country
1	Female	Makerere Regional Center for Crop Improvement (MaRCCI), Makerere University	Master's	Plant Breeding & Genetics	Feb-21	N	Ghana
2	Female	The University of Georgia	Post-doctoral Studies		Sep-22	N/A	United States
3	Male	LUANAR	Master's	Crop production	May-21	N	Malawi
4	Female	The University of Georgia	Post-doctoral Studies		Sep-22	N/A	United States
5	Male	High School for Agricultural Engineering, Thiès University/ENSA	Master's	Agricultural Engineering	Sep-22	N	Senegal
6	Male	University for Development Studies (UDS)	Master's	Biotechnology	Sep-20	N	Ghana
7	Female	Makerere Regional Center for Crop Improvement (MaRCCI), Makerere University	Master's	Plant Breeding & Genetics	Oct-21	N	Kenya
8	Male	Texas Tech University	Master's	Plant and Soil Science	Nov-22	N	Ghana
9	Male	National Superior School of Agriculture (ENSA), University of Thiès	Master's	Agricultural Engineering	Dec-20	N	Senegal
10	Male	ICRISAT	Ph.D.	Agrophysiology	Nov-22	N	Niger
11	Male	University of Georgia	Ph.D.	Agricultural and Applied Economics	Aug-22	N	United States
12	Female	Makerere Regional Center for Crop Improvement (MaRCCI), Makerere University	Ph.D.	Plant Breeding & Genetics	Aug-22	N	Uganda
13	Male	Makerere Regional Center for Crop Improvement (MaRCCI), Makerere University	Master's	Crop Science (Crop Protection)	Dec-21	N	Uganda
14	Female	University of California at Santa Barbara	Ph.D.	Geography	Jul-23	N	United States
15	Female	ICRISAT	Ph.D.	Agronomy	Nov-22	N	Niger

Trainee Number	Gender	University	Degree	Major	Program End Date (month/year)	Degree Granted	Home Country
16	Female	National Superior School of Agriculture (ENSA), University of Thiès	Master's	Agricultural Engineering	Mar-21	N	Senegal
17	Male	Ecole Nationale Superieure d'Agriculture de Thiès	Master's	Agricultural Economics	Jan-21	N	Senegal
18	Female	University of Tennessee	Master's	Agricultural Leadership, Education and Communications	Dec-20	N	United States
19	Male	University of Thiès	Ph.D.	Agronomic Sciences	Dec-19	N	Senegal
20	Male	National Superior School of Agriculture (ENSA), University of Thiès	Master's	Agronomy with Rural Economics specialization	Dec-20	N	Senegal
21	Male	National Superior School of Agriculture (ENSA), University of Thiès	Master's	Agronomy with Rural Economics specialization	Jan-21	N	Senegal
22	Male	ISRA-CERAAS	Ph.D.	Molecular Genetics	Dec-22	N	Senegal
23	Female	ISRA/CERAAS	Ph.D.	Molecular Genetics	Dec-23	N	Senegal
24	Male	CSIR-College of Science and Technology	Master's	MPhil, Plant Breeding and Biotechnology	Aug-21	N	Ghana
25	Male	Lilongwe University of Agriculture and Natural Resources, Bunda College	Master's	Master of Science in Agronomy	Dec-21	N	Malawi
26	Female	Kwame Nkrumah University of Science and Technology (KNUST)	Master's	Agronomy	Dec-20	N	Ghana
27	Male	University for Development Studies	Master's	Biotechnology	Sep-21	N	Ghana
28	Male	Kwame Nkrumah University of Science and Technology (KNUST)	Ph.D.	Agronomy and Pest Management	Nov-22	N	Ghana
29	Female	The University of Minnesota	Post-doctoral Studies		Dec-21	N/A	United States
30	Female	University of California at Santa Barbara	Post-doctoral Studies		Dec-21	N/A	United States
31	Female	Mekerere University	Ph.D.	Agronomy	Jun-22	N	Kenya

Trainee Number	Gender	University	Degree	Major	Program End Date (month/year)	Degree Granted	Home Country
32	Female	Ecole Nationale Supérieur Agricole, University of Thiès	Ph.D.	Agronomy with Rural Economics specialization	Nov-22	N	Senegal
33	Male	University of Ghana	Master's	Plant Breeding	Dec-21	N	Ghana
34	Female	Makerere University	Master's	Plant Breeding and Seed Systems	Oct-21	N	Tanzania, United Republic of
35	Male	Makerere Regional Center for Crop Improvement (MaRCCI), Makerere University	Master's	Crop Science	Jan-21	N	Uganda
36	Female	LUANAR	Master's	Agronomy	May-21	N	Malawi
37	Female	Pennsylvania State University	Ph.D.	Rural Sociology	May-23	N	United States
38	Female	Centre de Recherche pour le Dévelopement Economique et Sociale	Ph.D.	Agricultural Economics	Jun-23	N	Senegal
39	Female	National Superior School of Agriculture (ENSA), University of Thiès	Master's	Agricultural Engineering	Jul-20	Y	Senegal
40	Female	Makerere Regional Center for Crop Improvement (MaRCCI), Makerere University	Master's	Plant Breeding & Genetics	Jun-21	N	Ghana
41	Female	Makerere University	Master's	Food Science and Technology	Dec-21	N	Uganda
42	Male	Ecole Nationale Superieure d'Agriculture de Thiès	Master's	Agricultural Economics	Jan-21	N	Senegal
43	Male	Kwame Nkrumah University of Science and Technology (KNUST)	Master's	Plant Breeding	Aug-22	N	Ghana
44	Male	University of Georgia	Ph.D.	Agricultural and Applied Economics	May-23	N	United States
45	Male	High School for Agricultural Engineering, Thiès University/ENSA	Master's	Agricultural Engineering	Sep-22	N	Senegal
46	Female	Makerere University	Master's	Agricultural and Applied Economics	Dec-21	N	Uganda
47	Female	Ecole Nationale Superieure d'Agriculture de Thiès	Master's	Agricultural Economics	Aug-21	N	Senegal
48	Male	SARI-UDS	Ph.D.	Agronomy and Pest Management	Apr-23	N	Ghana

Trainee Number	Gender	University	Degree	Major	Program End Date (month/year)	Degree Granted	Home Country
49	Male	ICRISAT	Master's	Genetics and Plant Breeding	Aug-20	Y	India
50	Female	Makerere University, School of Women and Gender Studies	Post-doctoral Studies	Post-Doctoral on Gender Studies and Development including Agriculture	Sep-22	N/A	Uganda
51	Female	Centre de Recherche pour le Dévelopement Economique et Sociale	Ph.D.	Agricultural Economics	Jun-24	N	Senegal
52	Male	National Superior School of Agriculture (ENSA), University of Thiès	Master's	Agricultural Engineering	Mar-21	N	Senegal

Innovation Transfer and Scaling Partnerships

Steps Taken

We continue to encourage partnerships between the public and private sector to more effectively move innovations forward. These have focused on decreasing the time required to release new varieties and the development of optimized equipment for shelling and sizing peanuts in the target countries.

Partnerships Made

A partnership between the Department of Agricultural Research (DARS), the national program in Malawi, and the private company, Pyxus Ltd., allowed new peanut varieties to be more rapidly assessed and the field data collected required by the release committee. A partnership with Frank's Design for Peanuts in the US provided various models of optimized peanut shelling and sorting equipment, appropriately scaled for Africa, to be designed, built and tested.

Technologies Ready to Scale

During FY2020, three new peanut varieties were approved for release in Malawi. These varieties provide improved disease resistance, drought tolerance and increased yields. The maturity and seed size and quality are those desired by farmers and appropriate for the Malawi and regional markets. A motorized sheller/aspirator optimized for handling various sizes of peanuts were built and sent to Pyxus Ltd. in Malawi for use at their buying points. A motorized grading table was also provided to help sort the shelled nuts to determine the grade of the peanuts.

Technologies Transferred

Seed of the new varieties is being made available to seed producers for increase in Ghana and Malawi. Six of the motorized shellers and grading tables were purchased by Pyxus Ltd. in Malawi for use at their buying points.

Technologies Scaled

No technologies are considered scaled at any significant level yet. Seed of the new varieties is being produced and will be available for some farmers as early as next cropping season. Additional seed increases will occur next season leading to more availability of seed. A few of the motorized shellers and grading tables are being used by one private company, Pyxus Ltd., in Malawi.

Environmental Management and Mitigation Plan (EMMP)

Approval obtained for use of herbicides and insecticides in peanut field research in Ghana, use of insecticides in Malawi, and fertilizers in Senegal.

Open Data Management Plan

All PIs and project partners are briefed on the Peanut Innovation Lab Data Management Plan. The Director and Assistant Director monitor compliance with the plan and work with each project to identify data sets that will arise from project research. These are entered into the Piestar DPx system to follow progress towards submission to the appropriate repository. All projects must complete the DPx Data Management module as part of the semi-annual and annual reporting process.

No data is ready for submission during this period.

Governance and Management Entity Activity

Project, program and student events

The lab completed a series of start-up meetings that brought together project teams across the focus country – including PIs, co-PIs, in-country partners and students – to discuss all the projects happening in those countries, find synergies between projects, and begin working with in-country graduate students.

The management entity has found this approach particularly helpful in getting students integrated into the program early and with a clear understanding how their research fits into the overall project.

Due to COVID-19, the planned Annual Research Meeting in Malawi in May was cancelled and rescheduled as a virtual meeting in July. While virtual meetings cannot replace in-person events, the participation was much greater in the virtual meeting with over 100 researchers attending the three-day event. Feedback was very positive and the suggestion made to make all future events a hybrid-event by providing both in-person and virtual options.

A series of four half-day events were organized in August to allow 35 graduate students to present and discuss their research projects. Based on the feedback from the students, the ME is organizing a Brown-bag seminars for all students on a monthly basis. These informal events will allow the students to discuss topics beyond their research such as publishing, presenting talks, seeking funding, etc. The first seminar will take place before the end of 2020.

Gender-responsive research training

Building on the focus of gender and youth considerations in agriculture, the lab held trainings both in the U.S. and Uganda to broaden scientists' understanding of the issues surrounding gender.

In December, PIs from the five projects specifically focused on gender and youth met in Athens to discuss their research plans. Those researchers represent several disciplines – agricultural economics, agricultural leadership, and geography – at universities across several states. In conjunction with their meeting, the lab held a workshop on gender responsive research for faculty, students and staff across the University of Georgia community.

In March, the lab held three days of gender training executed by the GREAT (Gender-Responsive Researchers Equipped for Agricultural Transformation) team and Makerere University, the first in a series of intensive workshops to help researchers understand how best to consider gender in their work.

The lab is planning other three-day GREAT trainings for West Africa in English and French. Timing will depend on recovery from the global COVID-19 pandemic.

SAWBO videos and Groundnut Academy

With the transition to more virtual training and events, the ME developed a partnership with the SAWBO (Scientific Animations Without Borders) at Michigan State University to produce two animated videos on groundnut production. The first will focus on proper land preparation, choice of varieties, planting density and early weed management. The second will present how to determine when to harvest, dry and store the crop. The videos will be initially used as part of the on-going training for extension agents and farmers in Malawi. Narration will be in English and Chichewa with both male and female voices. A brief phone survey will be administered to farmers working with distributing partners to evaluate the first video and monitor distribution methods.

A partnership with University of Florida will develop an initial set of four online courses in groundnut agronomy best practices, pest management, harvesting/drying/storage, and aflatoxin management. Each course will feature narrated lectures, short quizzes and a final course exam. A certificate of completion will be provided for all completing a course. Additional courses may be added in the future, depending on interest and demand.

Africa-wide collaboration

Through previous programs, the Peanut Innovation Lab has encouraged collaboration between peanut breeders in national programs across Eastern and Southern Africa. Breeders in Uganda, Mozambique, Malawi and Zambia have set up a professional network and share discoveries and insights through WhatsApp.

Through projects to tap into the genetic potential of peanuts grown across the continent the program is empowering African peanut breeders to make broader professional connections that will last beyond the program.

Dual benefits

The management entity continues to explore the dual benefits of work between African and U.S. partners to strengthen those connections and to highlight the outcomes.

Laying the groundwork for a project in Ghana to evaluate the effectiveness of a school snack developed by Washington University's Mark Manary, for example, the innovation lab forged a partnership between the Feed the Future project, Virginia-based Birdsong Peanuts and the (U.S.) National Peanut Board, each of which are investing in the research project.

Similarly, a project by Peggy Ozias-Akins to genotype accessions of African origin from the USDA peanut germplasm collection has funding from the Peanut Research Foundation, a US peanut industry supported foundation. While this work directly benefits African breeding programs, US partners also see a benefit here from a better understanding of the diversity of peanut.

Program management

The Piestar DPx project management software was used to request and receive progress reports for this report. The Management Entity has worked with Piestar to develop the modules for the project PIs and other scientists to report progress, request approvals to travel, purchase supplies, train students and register for events. Modules also have been implemented to collect information on project progress, degree training, short-term training events, data management, EMMP activities and technology pipelines, as well as for PIs to submit annual work plans and budgets.

Given the impacts of COVID-19 on many ME and project activities, all projects were requested to submit updated workplans and budgets for the remainder to the Peanut Innovation Lab. Each project is to consider the need to extensions to complete the original objectives. The revised project details will be incorporated into a revised workplan and budget for the entire Peanut Innovation Lab to be submitted in early FY2021.

Presentations and Publications

Hoisington, D. 2020. VICAM Peanut Aflatoxin Seminar (Virtual).

Hoisington, D., Rhoads, J., Marter-Kenyon, J. & Floyd, A. 2020. Feed the Future Innovaiton Lab for Peanut – Addressing constraints to peanut productivity and use. Presentation at the 52nd American Peanut Research and Education Society Meeting (Virtual).

Arias, R. S., Mohammed, A., Orner, V. A., Faustinelli, P. C., Lamb, M. C. & Sobolev, V. S. 2020) Sixteen draft genome sequences representing the genetic diversity of *Aspergillus flavus* and *Aspergillus parasiticus* colonizing peanut seeds in Ethiopia. pp.1-3. Microbiology Resource Announcements, 9(30): 1-3. doi:10.1128/MRA.00591-20.

Chimbaza, M., Kankwamba, H., Mwangwela, A. M. & Kamthunzi, W. 2020) Post-harvest groundnut aflatoxin management among smallholder farmers in Malawi. World Mycotoxin Journal 13(1): 37-43.

Fulmer, A. M., Brenneman, T. B., Kemerait, R. C., Macajoux, R., Carroll, D. A., Faroutine, G., Sheard, W., Dorzan, P., Rhoads, J. A. & MacDonald, G. E. 2020. Evaluation of improved valencia peanut varieties for production in Haiti. Peanut Science 47: 1-8.

Other Topics

None to report.

Issues

None to report.

Future Directions

Peanut lines that enhance the existing set of 300 core lines will be added based on the analysis of the over 3700 lines genotyped from the African national programs and the USDA germplasm collection. The core 300 lines representing the diversity of African peanut varieties will be evaluated for disease resistance and drought tolerance in trials conducted by the national programs in Senegal, Ghana, Uganda, Malawi, Zambia and Mozambique. Seed will also be provided to the national programs in Mali, Niger and Togo that contributed materials originally. Field trials will be conducted in these countries during the FY21 cropping season. Other countries in Africa have expressed interest in evaluating the lines and an effort will be made to provide seed to these programs.

Evaluation of lines derived from wild relatives will be evaluated for a second season in Senegal and Uganda under leaf disease pressure to confirm the high level of resistance to these constraints identified in the first season. Molecular markers for groundnut rosette resistance will be confirmed in field trials and made available to breeding programs for use to cross resistance into new varieties.

Biochemical resistance to *Aspergillus flavus*, fungal pathogen to causes aflatoxin contamination, will be confirmed in the highly line identified as highly resistant and other lines screened for possible similar levels of resistance.

A second season of field trials of production packages employing quality seed, inoculants, fertilizers and weed control will be conducted in Ghana and Malawi to determine optimal packages for farmers. GPS locations, cultivate crop and yield estimates will be collected for farms in Malawi and Senegal to confirm the use of satellite imagery to determine peanut fields and estimate yields.

Animated videos on groundnut production practices will be deployed in Malawi and other countries. Feedback will be collected to determine the initial impact of these on improving interest by farmers to adopt new technologies. Virtual courses will be launched in a Groundnut Academy to provide students, technicians and scientists training options in a range of groundnut topics.

Motorized sheller/aspirator and grading equipment will be provided to national programs in Senegal, Ghana, Uganda, Malawi, Zambia and Mozambique along with training on its use and maintenance. Breeding and seed production programs will be able to use the equipment to more efficiently shell peanuts in variety trials and seed production nurseries increasing go the seed and decreasing the time spent shelling.

School feeding trials will be conducted in northern Ghana to assess the impact of the novel peanut-based school foods on cognitive learning and health. Feeding trials using locally produced peanuts will be conducted in Uganda to evaluate the effect of peanuts on the gut microbiome in school children. The samples collected will be sent to the USA for evaluation.

Youth in Uganda will be trained to take photos to start the photovoice project. Several visits by the project team will occur during FY21. Following the trial tests of the time monitoring device, the project will begin deploying the devices in the Kaolack area of Senegal and then monitoring their use during FY21. Two additional surveys on time-use will be conducted in northern Ghana to obtained data at different times of the year.

A second year of field trials to determine the impact of the optimize shrubs system on groundnut production in Senegal will be conducted, including training for farmers.

Appendix A. List of Awards to U.S. Partners

Institution	Project Name	Start Date (mm/dd/yy)	End Date (mm/dd/yy)	FY 2020 Budget	Total Budget
California				**$212,503**	**$431,758**
Stanford University	Examining the Utility of Satellite-based Assessment in a Maize/Peanut Agroecosystem for Estimated Crop Response in Malawi *(sub-award from NCSU)*	10/1/2018	9/30/2021	$31,000	$65,000
University of California, Santa Barbara (UCSB)	Gender, Fertility, and Intra-household Dynamics and resilience in the Senegalese Peanut Farmers in Ghana	7/1/2019	12/31/2021	181,503	$366,758
District of Columbia				**$37,125**	**$122,051**
International Food Policy Research Institute (IFPRI)	Connecting Male and Female Smallholder Farmers to Premium Groundnut Markets and Aflatoxin-mitigating Technologies through Innovation Aggregator Contracts *(sub-award from UGA)*	8/1/2018	7/31/2022	$37,135	$122,051
Florida				**$5,040**	**$15,120**
University of Florida (UFL)	Development and Delivery of Improved Production and Pest Management Packages to Peanut Farmers in Ghana *(sub-award from NCSU)*	10/1/2018	9/30/2022	$5,040	$15,120
Georgia				**$339,748**	**$1,268,936**
University of Georgia (UGA)	Leveraging Genetics Resources to Enhance Peanut/Groundnut Breeding in Africa and the United States	10/1/2018	9/30/2022	$0	$21,700
	Use if Novel Genetic Diversity for Peanut Varietal Development in East Africa	9/1/2018	9/1/2021	$19,320	$110,000
	Incorporating New Wild Alleles to Improve Elite African Peanut Cultivars	10/1/2018	9/30/2021	$53,252	$110,000
	Mapping Groundnut Rosette Virus (GRV) Resistance to Marker-assisted Selection	10/1/2018	9/30/2021	$17,850	$93,080
	Connecting Male and Female Smallholder Farmers to Premium Groundnut Markets and Aflatoxin-Mitigating Technologies through innovation Aggregator Contracts	8/1/2018	7/31/2022	$75,076	$215,331
	Identifying the Alternative Host for Groundnut Rosette Disease Virus Complex	8/1/2018	2/1/2021	$9,600	$32,800
	Regulation of Gut Microbiome by Peanut Supplement in Youth with both Genders	4/1/2019	9/30/2022	$124,682	$453,555
	Enhancing the Genetics Potential of Peanut Production in Eastern/Southern Africa *(sub-award from NASARRI)*	2/1/2019	7/31/2022	$0	$15,400
	Enhancing the Genetics Potential of Peanut Production in West Africa *(sub-award from ISRA)*	2/1/2019	7/31/202	$0	$15,400
	Genotypic Analysis of Peanut using Axiom_Arachis2 SNP Array	5/1/2018	4/30/2019	$0	$106,670

Institution	Project Name	Start Date (mm/dd/yy)	End Date (mm/dd/yy)	FY 2020 Budget	Total Budget
	Retaining Next Generation Farmers in the Senegalese Groundnut Basin *(Sub-award from Virgina Tech)*	3/1/2019	2/28/2022	$39,968	$95,000
USDA-ARS National Peanut Research Laboratory (NPRL)	Technical Evaluation of PICs Bags for use with Shelled Peanuts	5/1/2018	4/30/2019	$0	$0
Missouri				**$236,038**	**$499,732**
Washington University (WU)	Integrating the Power of Peanuts into School Feeding	1/1/2019	9/30/2022	$236,038	$499,732
North Carolina				**$101,410**	**$330,140**
North Carolina State University (NCSU)	Examining the Utility of Satellite-based Assessment in a Maize/Peanut Agroecosystem for Estimated Crop response in Malawi	10/1/2018	9/30/2021	$27,481	$86,604
	Development of Efficient Agronomic Peanut Production Packages for Malawian Farmers	10/1/2019	7/31/2022	$43,839	$113,811
	Development and Delivery of Improved Production and Pest Management Packages to Peanut Farmers in Ghana	10/1/2018	9/30/2022	$30,090	$129,725
Ohio				**$39,175**	**$203,979**
Ohio State University (OSU)	Optimized Shrub System (OSS): an Innovation for Landscape Regeneration and Improved Resilience for the Peanut-Basin on Senegal	9/1/2018	8/31/2022	$39,175	$203,979
Pennsylvania				**$95,200**	**$371,329**
Pennsylvania State University (Penn State)	Time Poverty among Women Smallholder in Ghana: implications for Gender Priorities in the Peanut Value Chain	3/1/2019	10/31/2022	$95,200	$371,329
Tennessee				**$71,344**	**$180,414**
University of Tennessee (UT)	Photovoice for Youth Empowerment in Peanut Value Chain	3/1/2019	2/28/2022	$71,344	$180,414
Texas				**$111,811**	**$265,590**
Texas Agriculture and Mechanical College (Texas A&M)	Breeding and Enhancement of Tolerance to Water Deficit, Resistance to leaf Spot and Improved Oil Composition on Peanut	10/1/2018	9/30/2022	$33,864	$86,431
Texas Tech University (TTU)	Developing Aspergillus flavus Resistance Peanut using Seed Coat biochemical marker(s)	10/1/2018	9/30/2022	$77,947	$179,159
Virginia				**$76,961**	**$262,299**
Virginia Tech (VT)	Integration of High Throughput Phenotyping (HTP) for Enhancing Breeding Programs in Senegal, Ghana, Uganda, and Regional Cooperation	9/1/2018	11/30/2022	$16,380	$73,680
	Development and Delivery of improved Production and Pest Management Packages to Peanut Farmers in Ghana *(sub-award from NCSU)*	10/1/2018	9/30/2022	$5,040	$15,120
	Retaining Next Generation Farmers in the Senegalese Groundnut Basin	3/1/2019	2/28/2022	$55,541	$173,499

Appendix B. Success Stories

US entrepreneur tailors small-scale machines for shelling and grading

Through the USAID-funded Malawi Agriculture Diversification Activity (AgDiv), the Peanut Innovation Lab is helping smallholder farmers and agriculture production companies in Malawi diversify into a new crop, while also helping to make connections with US industry partners.

A challenge to developing formal peanut markets across Africa is aflatoxin contamination. Working with AgDiv and its in-country partners, the Innovation Lab piloted a novel system of small-scale machinery to help modernize the sector in Malawi by switching to in-shell trading, rather than buying and selling shelled nuts. This helps protect the nuts by leaving them in the shell longer and avoids a common practice people use when shelling by hand: Soaking pods in water, which makes shelling by hand easier, but increases the potential for aflatoxin contamination.

While buying in-shell can protect against harmful hand-shelling practices or avoid low-quality processing machines can damage nuts, buyers don't have a good way to evaluate the quality of the nuts they are buying because they can't see inside the shells. Existing cleaning, shelling and processing lines are fairly low-tech and can create additional loses by damaging the kernels and not effectively sorting out high risk kernels.

The Innovation Lab worked with US-based retired equipment manufacturer Frank Nolin to develop a high quality, small-scale shelling and sizing unit that could replicate the grading process developed by the USDA that mediates between farmers and shelling companies. AgDiv partner Pyxus International, an international agribusiness with a long history in Malawi, piloted this approach as part of their long-term commitment to resolve aflatoxin in the supply chain. The equipment was paired with a moisture meter and mobile aflatoxin testing kit as part of a "buying point in a box" that could help sort out good and bad lots and also incentivize farmers to deliver their best quality nuts.

The first year of use of the equipment presented some unexpected challenges for the approach due to the spread of COVID and subsequent lock-downs that happened just a month or so before harvest, but Pyxus was able to purchase nearly 1000MT of in-shell peanuts and has innovated unanticipated uses for the equipment, such as grading for their commercial seed business, and continues to conduct research on the best way to use the equipment. They are committed to making the switch towards in-shell purchasing, which is new to farmers and government agencies that regulate trade, including setting a target of purchasing 6500MT in 2021.

With that many peanuts, they have also invested in more established US technology, including a modern shelling line from the Georgia-based global leader in peanut processing, Lewis M. Carter (LMC) Manufacturing. When this equipment is installed, the buying point generated data can be better compared with end results of the processing and will hopefully help generate real value for both farmers and Pyxus, by paying for quality and avoiding co-mingling lots that have higher risk of aflatoxin contamination.

An additional research output of the buying point technology was evaluated in partnership with LUANAR researcher Dr. Limbikani Matumba and retired aflatoxin expert Tom Whitaker from the USDA-ARS for Food Science, Market Quality and Handling group co-located at North Carolina State University. An obstacle to aflatoxin testing for smallholder production is that the lots are too small to justify the sample sizes required for the destructive testing process. Sometimes the farmer lots are not much bigger than the sample size needed to assure accurate results, but you can't grind up the whole lot just to find the result. So, the researchers used the buying point system to concentrate the highest risk grade components, such as the immature and damaged kernels that get sorted out, to then grind and test and use the results to estimate the risk potential of the total lot. This may help segregate high risk lots from low risk lots and offer better strategies to manage aflatoxin risk.

Collaboration leads to new peanut varieties for Malawi

Three new groundnut varieties soon will be available in Malawi after the national program released new drought-tolerant Spanish-type varieties through a regional research collaboration and with support of the Peanut Innovation Lab, headquartered at the University of Georgia's College of Agricultural and Environmental Sciences. CG 15 & CG 16 gained approval early this year and will be available in limited quantities this season, while a third new variety was just approved for release and will be available next season.

To generate the new varieties, breeders working for the Malawi Department of Agricultural Research Services sourced materials from ICRISAT and tested these over several seasons, identifying the most resilient and highest yielding varieties that hold potential in the commercial market.

The groundnut breeding team in Malawi selected the varieties for their tolerance to drought, and started testing in the 2014/15 season under the Agricultural Productivity Program in Southern Africa (APPSA) project, said Justus Chintu, principal agricultural research scientist for groundnut breeding at the Chitedze Research Station near Lilongwe. That project finished before variety testing was complete, so the Peanut and Mycotoxin Innovation Lab and Peanut Innovation Lab finished out the on-farm trials and extra on-station trials.

Chintu and the DARS team completed the trials in the 2019/20 season testing the varieties in collaboration with Limbe Leaf and Pyxus, two commercial agricultural production companies in Malawi. Those companies are working with the USAID-funded Malawi Agricultural Diversification Activity, a partner of the Peanut Innovation Lab.

"We were linked to Pyxus and Limbe Leaf by the Peanut Innovation Lab and Malawi Agricultural Diversification Activity," Chintu said. "We have been testing on their farms for two seasons which helped us identify the best ones for release. In addition, two varieties (CG 15 & CG 16) were also identified and released last year in Mozambique, where we are collaborating with Dr. Amade Muitia, peanut breeder with IIAM in Nampula."

The latest groundnut variety approved in Malawi, which was released for the 2015 season under the name "Wamusanga" in Zambia, shows potential for the South African export market, which prefers small Spanish types over the more common Virginia types grown by the majority of famers in Malawi. Good Nature Agro, a social enterprise based in Zambia that has recently expanded to Malawi, along with Limbe Leaf and Pyxus, expressed interest in growing Wamusanga to export to South Africa. To authorize the variety for release in Malawi, the DARS team evaluated the variety both on-farm and on-station during the 2019/20 season.

To gain the required second year of data, Chintu turned to a colleague in Zambia, groundnut breeder Lutangu Makweti with the Zambian Agricultural Research Institute. The Peanut Innovation Lab has supported collaboration between a network of groundnut breeders in Africa who share knowledge, variety performance data and germplasm to make strides as a pan-African team. Makweti was able to provide field data from just over the border in Eastern Zambia that allowed Chintu to obtain the permit to release the latest variety this year.

In Malawi, the new variety likely will be called Wamsanga (CG 17), a bit different from the name in Wamusanga that is used in Zambia.

Gender awareness informs all research activities through training

Researchers and practitioners are increasingly aware that gender matters within agriculture and food systems. Gender is also a cross-cutting theme within the Innovation Labs and a core component of the Peanut Innovation Lab's research and training portfolio. However, many scientists – particularly those trained in the biophysical sciences – may have a superficial grasp of *why* gender matters and are unsure how to operationalize it in their research beyond creating gender parity in staffing, student support, or survey work. The Peanut Innovation Lab recognized the need for more hands-on work in this area.

The Peanut Innovation Lab partnered with GREAT (Gender-Responsive Researchers Equipped for Agricultural Transformation) and Makerere University to design and deliver an immersive, interactive, three-day gender-in-agriculture sensitization and training workshop. GREAT is a partnership between Makerere and Cornell University that provides applied gender training to agricultural researchers in sub-Saharan Africa.

From March 10-12, two dozen graduate students and scientists working with the lab on seven projects in eastern and southern Africa came to Kampala, Uganda to participate in the training. The participants have disciplines as diverse as plant breeding, nutrition, agricultural economics, food science, plant pathology and genetics. Several of the scientists also work for the national agricultural programs in their home countries, including representatives from Uganda, Malawi, Mozambique and Zambia.

The workshop focused on the basics of gender theory and related concepts, why gender matters in agriculture and peanut value chains, and how to function in interdisciplinary research teams. Towards the end of the workshop participants met in their research teams, took a hard look at their project's initial approach to gender and reflected on concrete ways to improve the gender-responsiveness of their Lab-funded work.

Peanut Lab scientists and students were able to think critically about the relationship between gender and agriculture, in order to define and address the gender-responsive questions that could expand the scope or impact of their work. In a post-workshop survey, 94% of participants said the course had significantly changed their technical knowledge, and 88% said the training "greatly" changed their attitude towards gender-responsive research. Several participants also reported that the training improved their ability to discuss gender concepts in funding proposals and academic writing; others noted the training helped them to reconsider how social constructs and biases related to gender influence their family and work relationships.

Organizers and participants noted a few aspects that made the training so successful. First, the concepts were presented in an African context by an African research institute; this allowed participants to engage more deeply and ensured course materials were relevant. Second, scientists and students trained together; this fostered an atmosphere of communal learning/sharing and empowered students interested in incorporating gender-responsive thinking in their graduate work (by increasing buy-in from their advisors). Third, training biophysical scientists alongside their social science colleagues allowed for cross-disciplinary discovery; project teams that do have a strong focus on gender helped elevate the importance of that issue to teams working in other research areas.

The training in Uganda is one of several gender training workshops the Peanut Innovation Lab has planned. Others will take place in the U.S., Ghana and Senegal (in French).

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