



Collaborative Research
on Sorghum and Millet

KANSAS STATE
UNIVERSITY



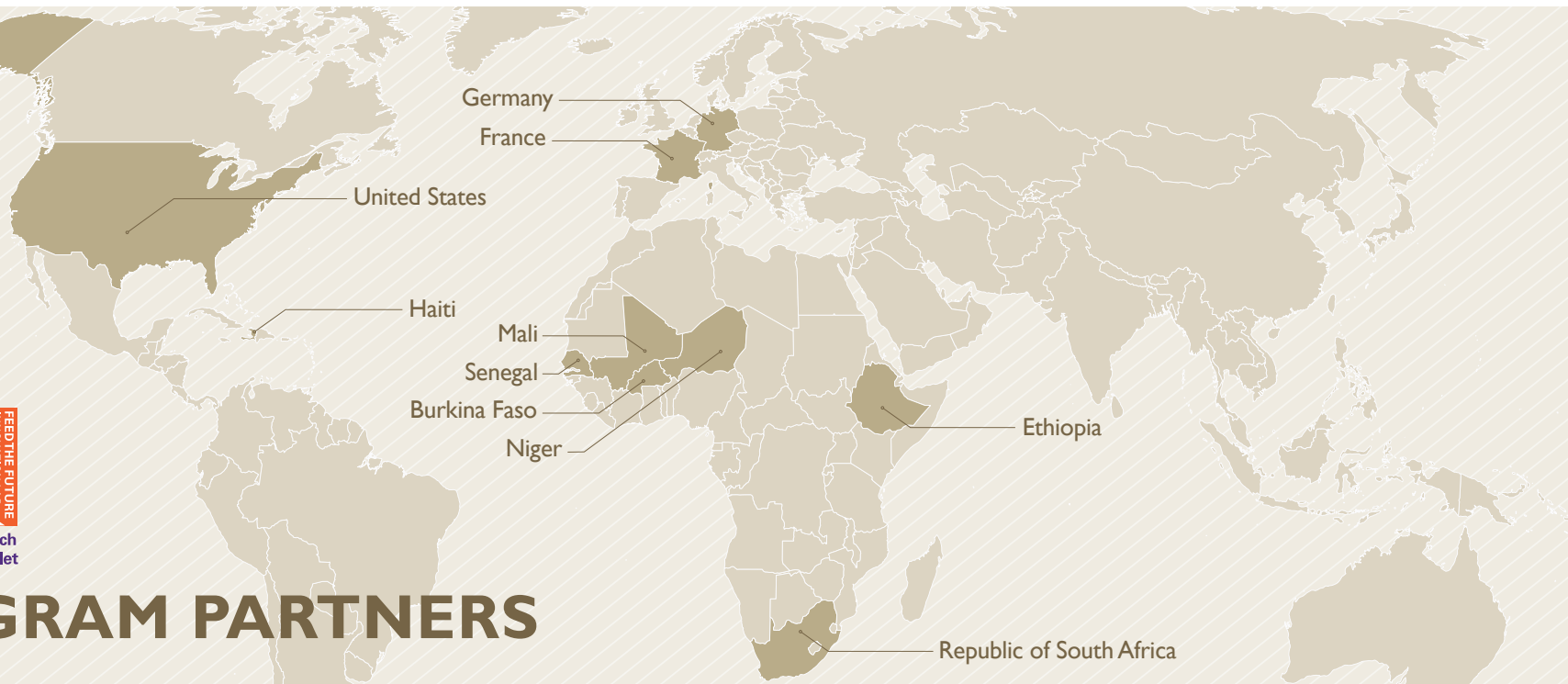
USAID
FROM THE AMERICAN PEOPLE

ACTIVITIES & IMPACTS REPORT



Collaborative Research
on Sorghum and Millet

PROGRAM PARTNERS



United States

- Cornell University
- Integrated Pest Management Innovation Lab
- Kansas State University
- Kansas State University – Western Kansas Agricultural Research Center, Hays
- Purdue University
- Texas A&M AgriLife Research
- Texas A&M University
- USDA-Agricultural Research Service
- Virginia Tech University
- West Texas A&M University

Ethiopia

- Amhara Regional Agricultural Research Institute
- Ethiopian Institute of Agricultural Research
 - Asosa Research Center
 - Bako Research Center
 - Melkassa Research Center
 - Pawe Research Center
 - Sirinka Research Center
- Haramaya University
- Hawassa University
- Holleta Biotechnology Center
- Oromia Regional Program
- Tigray Regional Agricultural Institute

Senegal

- Centre d'Etudes Régional pour l'Amélioration de l'Adaptation à la Sécheresse
- Centre National de Recherche Agronomique
- FAPAL (farmer organization)
- Institut Sénégalais de Recherches Agricoles
- Institut de Technologie Alimentaire
- University Cheikh Anta Diop de Dakar

Niger

- Fuma Gaskiya (farmer organization)
- HALAL (farmer organization)
- Institut National de la Recherche Agronomique du Niger
- International Crops Research Institute for the Semi-Arid Tropics
- LSDS (farmer organization)
- University of Maradi

Mali

- Institut d'Economie Rurale

Burkina Faso

- Institut de l'Environnement et de Recherches Agricoles

Haiti

- CHIBAS

Germany

- University of Hohenheim

France

- Centre de Coopération Internationale en Recherche Agronomique pour le Développement

Republic of South Africa

- University of Pretoria



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INNOVATING SCIENCE TO BUILD THE CROPS OF THE FUTURE



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BETTER CROPS FOR A STRONGER FUTURE

The Feed the Future Innovation Lab for Collaborative Research on Sorghum and Millet is a global hub of cutting-edge research focused on increasing the resiliency of small-scale sorghum and millet producers in the face of climate change and creating entrepreneurial opportunities to reduce poverty and hunger.

WHAT WE ARE DOING

CLIMATE-SMART AGRICULTURE

Harnessing both time-tested breeding methods as well as the most advanced in genomic tools to create new crop varieties that are more drought, disease and pest resistant for improved yields and higher incomes for the smallholder farmer.

IMPROVED RESILIENCE

Designing innovative production techniques aimed at improving crop performance while combatting devastating pests in order to increase food security throughout rural areas.

MARKET ACCESS AND DEMAND

Working to drive improved nutrition, business opportunities and higher crop value through a new wave of processed and fortified food products that meet growing demands by urban and rural populations alike.



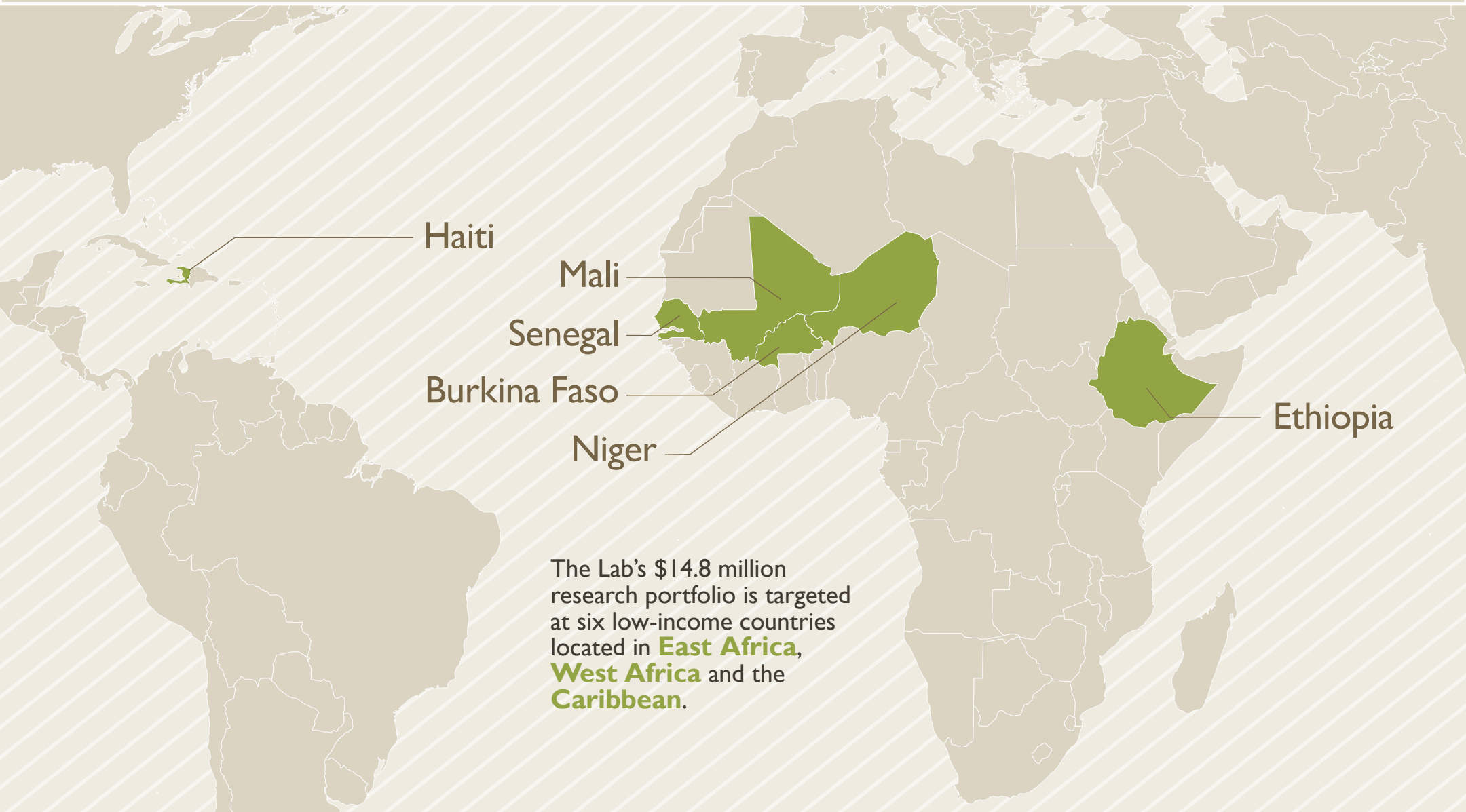
PROGRAM TEAM



2017 SMIL Annual Review Meetings - Mbour, Senegal

The Lab's program team is made up of more than **100 researchers, students and development experts** from across **10 different countries** and representing a **variety of institutions**, including national agricultural research systems, universities, research centers and farmer organizations spanning a **wide range of disciplines**, including breeding and genetics, agronomics, pest management, economics, food science and more.

WHERE WE WORK



NATURE'S LINE OF DEFENSE

INTEGRATED APPROACH OFFERS HOPE FOR NATURAL, SUSTAINABLE CONTROL OF DEVASTATING MILLET PEST IN WEST AFRICA

Pearl millet serves as a staple crop to millions of smallholder farmers and their families around the world. Due to its heat resistance and drought tolerance, it has the ability to grow and even thrive in low-quality, arid soils that can support few other crops.

But pearl millet has its weaknesses, and one of those is its susceptibility to certain insect pests. Across the African Sahel - where millet is an irreplaceable base to the diets of humans and livestock alike - the millet stem borer and millet head miner are considered the major chronic millet pests, known for wreaking havoc and causing major destruction to entire fields of production. In fact, infestation from one or both of these pests can lead to near or complete crop failure in a given year - a truly devastating prospect for a family already living on the fringes of food insecurity.

Exciting new research around the life cycles of these pests and their natural predators is pointing to a potential solution that would offer a natural, sustainable method for managing the millet head miner and stem borer and save millions of hectares of millet each year. The project, funded under the Feed the Future Innovation Lab for Collaborative Research on Sorghum and Millet, focuses on controlling the pests through the release of a naturally-occurring parasitoid wasp that targets both the head miner and stem borer and kills them, effectively controlling the population.

According to Malick Ba, the project's principal investigator and researcher at ICRISAT-Niger, the use of the parasitoid wasp to target the millet head miner in the Sahel has been successfully achieved in the past. However, under the Innovation Lab project, researchers are identifying a new predator that targets both the head miner and the stem borer simultaneously, offering the exciting possibility of dual-control of the two pests by the same parasitoid wasp.

Ba and his team are continuing to dig further into mass rearing of the parasitoid wasp, identifying host acceptability among locally-occurring moths and other insects, and so far the results are promising. The researchers have already started on-farm trials and trainings to test the effectiveness of the wasps at the village level. The team is also working with local farmers groups and cooperatives to explore the economics and optimal business model for an entrepreneur-led cottage industry for wasp rearing that would help position the innovation towards larger-scale adoption.

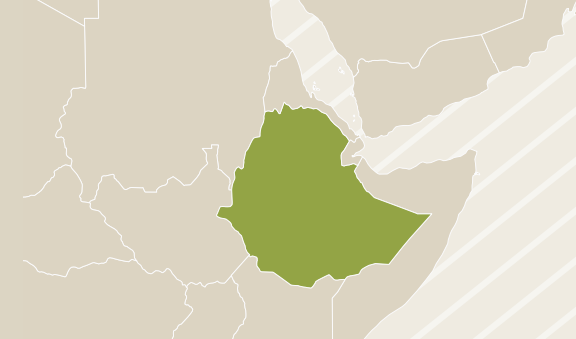
Many questions still remain to be answered through continued research studies, but the possibility of controlling two of the most devastating pearl millet pests in the Sahel is an exciting prospect for Africa's farmers, and everyone that depends on them.

Right: The millet head miner spirals along the length of a millet panicle, destroying a farmer's livelihood along the way.



RESEARCH FOR DEVELOPMENT

PROJECT UPDATES - ETHIOPIA



Genetic enhancement of sorghum to promote commercial seed supply and grain market development in Ethiopia

Principal investigator: Gebisa Ejeta

Lead institution: Purdue University

Collaborating institutions: Kansas State University, EIAR, Holleta Biotechnology Center, Tigray Regional Program, Oromia Regional Program, Haramaya University

Latest achievements:

This project continues to focus on the phenotyping of an Ethiopian core collection for Striga resistance at multiple sites and will link this to genetic information once the collection is genetically mapped.

Building upon funding from the Bill and Melinda Gates Foundation and the development of a Striga lab at Holetta, this project has trained technicians and graduate students from several Ethiopian institutions on DNA analyses and lab phenotyping in order to generate information on breeding for Striga resistance.



Improved crop genetics, production practices and processing methods for increased productivity and nutrition for smallholder sorghum producers in Ethiopia

Principal investigator: Tesfaye Tesso

Lead institution: Kansas State University

Collaborating institutions: USDA-ARS, Purdue University, KSU - Hays Research Station, EIAR, Tigray Agricultural Research Institute, Haramaya University

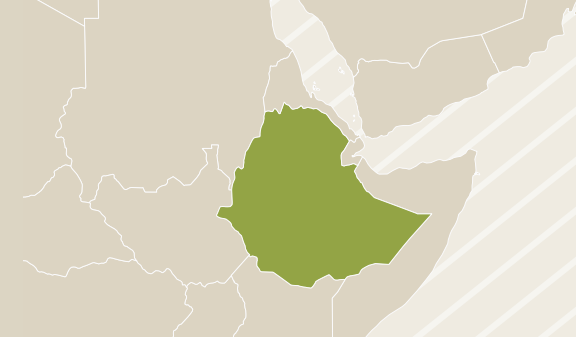
Latest achievements:

The Ethiopian core germplasm collection under examination in this project was replanted for a third year in six locations to collect additional phenotype information to complement the drought-plagued year of 2015. New breeding populations that advanced lines to F4 families and those with high nutritional qualities are being evaluated in multi-locational trials in 2017. In addition, efforts were initiated to characterize the population for nutritional quality and protein digestibility, both highly important end use traits.

For full project descriptions, please visit: k-state.edu/smill/whatwedol/projects/index.html

RESEARCH FOR DEVELOPMENT

PROJECT UPDATES - ETHIOPIA



Genetic improvement of sorghum for resistance to fungal pathogens

Principal investigator: Tesfaye Mengiste

Lead institution: Purdue University

Collaborating institutions: Kansas State University, EIAR, Holleta Biotechnology Center

Latest achievements:

The groundwork to initiate the sequencing of the Ethiopian core collection has been established and materials and supplies for this activity have been delivered to Melkassa after clearing importation hurdles. The post-doc recruited to conduct this analysis has started at Purdue University. A subset of varieties from the Purdue collection obtained from the Ejeta lab have been identified as possessing dual resistance to anthracnose and grain mold and these materials have been crossed with locally preferred but susceptible varieties.

Within the Ethiopian core collection, about 8 percent of 225 lines exhibited resistance to anthracnose at Assosa, which may represent additional mechanisms of plant resistance. Recombinant lines of resistant and susceptible lines have helped to identify specific regulators and mechanisms of function that is designated as Anthracnose Resistance Gene I (ARGI). Work continues to explore this further.



Developing superior functionality in sorghum for food applications to promote sorghum value chain in Ethiopia

Principal investigator: Joseph Awika

Lead institution: Texas A&M University

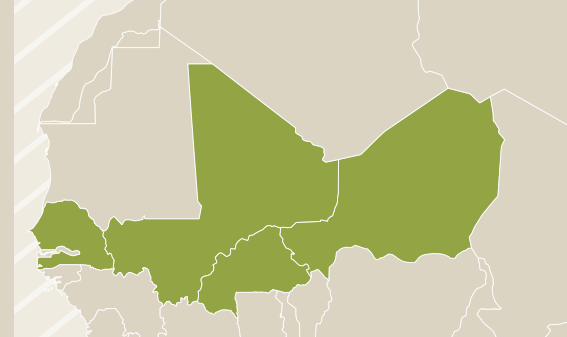
Collaborating institutions: Hawassa University, University of Pretoria

Latest achievements:

Improved high digestible (IHD) sorghum varieties outperformed Ethiopian checks in most quality traits. There is also a superior functional advantage of these lines (in volume and tenderness) when compared to locally available sorghum varieties. A micro-screening assay test for predicting performance of small quantities of sorghum on injera texture was developed to confront the problem of limited access to sufficient seed quantities of new varieties. When IHD is mixed at a 10 percent rate with wheat, the products had a similar acceptability rate to hard rolls and pan bread made with a 100 percent wheat formulation. This may lead to an avenue to substitute inexpensive sorghum in for expensive wheat in bakery products. A standardized injera-making protocol was developed in collaboration with female injera entrepreneurs and acceptability was evaluated with a consumer-oriented sensory panel of 36 individuals. In addition, experiments on the malting qualities of improved high protein digestible/waxy sorghum lines was initiated in South Africa at the University of Pretoria.

RESEARCH FOR DEVELOPMENT

PROJECT UPDATES - WEST AFRICA



Improving sorghum adaptation in West Africa with genomics-enabled breeding

Principal investigator: Geoffrey Morris

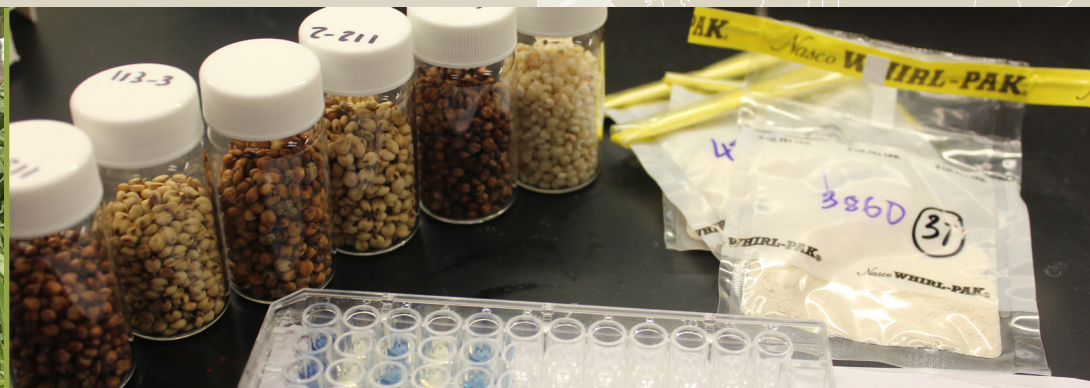
Lead institution: Kansas State University

Collaborating institutions: CIRAD, ISRA, CERAAS, CNRA, ICRISAT, INRAN, LSDS, HALAL

Latest achievements:

Three West African Ph.D. students have characterized the genomes of nearly 2,000 West African landraces and breeding lines to lay the foundation for genomics-assisted breeding. Three seasons are completed with the fourth planted at the end of 2016. Phenotyping for Striga resistance in Konni has been successful but phenotyping for drought has been mixed.

Preliminary analysis of the Senegal mini-NAM (F4 generation) has been completed at CERAAS using the KASP marker system. This information will be combined with phenotyping information to further strengthen breeding efforts.



Sorghum trait development pipeline for improved food and feed value

Principal investigator: Mitchell Tuinstra

Lead institution: Purdue University

Collaborating institutions: ITA, CERAAS, ISRA, CNRA, INRAN

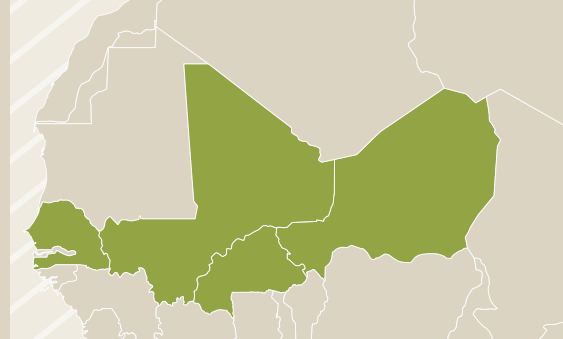
Latest achievements:

A forward genetic screen of additional unsequenced sorghum EMS mutants was used to identify a new mutant with highly digestible protein in the kernels. Three EMS mutants with highly-digestible protein have been identified to date. A specific mutant (P721Q) is a high lysine sorghum mutant that exhibits 3- to 4-fold increase in protein digestibility after cooking as compared to other sorghum cultivars, addressing an important challenge in sorghum's nutritional availability.

Mutations that influence starch quality were also identified. An additional mutant with high protein digestibility in sorghum forage was validated in 2016 in addition to the three mutants that were previously identified in 2015 (and subsequently crossed with TX623). Thirty-four elite parent lines and 127 breeding lines derived from crosses with West African germplasm were sent to INRAN for further evaluation.

RESEARCH FOR DEVELOPMENT

PROJECT UPDATES - WEST AFRICA



Development of biotic stress-resistant sorghum cultivars for Niger and Senegal

Principal investigator: Bonnie Pendleton

Lead institution: West Texas A&M University

Collaborating institutions: Texas A&M AgriLife Research, ISRA, CNRA, CERAAS

Latest achievements:

Using international disease, insect and drought line nurseries, this project identified nine international varieties with high degrees of host plant resistance to stresses. These lines were reevaluated in 2016 and continued resistance (or tolerance) will be used to confer better host plant protection in locally adapted sorghum varieties. The midge line tolerance nursery was evaluated in Texas because tolerance to midge is universally conferred. The resistance of 10 sorghum genotypes and mechanisms of resistance to two storage pests found in Senegal and Niger was investigated. In addition, the effectiveness of botanicals to control the maize weevil and the red flour beetle in stored sorghum was investigated. Recommendations were transferred to farmers and grain merchants in Senegal and Niger to contribute to their insect management practices.



Development of dual-purpose pearl millet varieties for the benefit of farmers and agro-pastoralists in the Sahelian and Sudanian zones of West Africa

Principal investigator: Roger Zangré

Lead institution: INERA

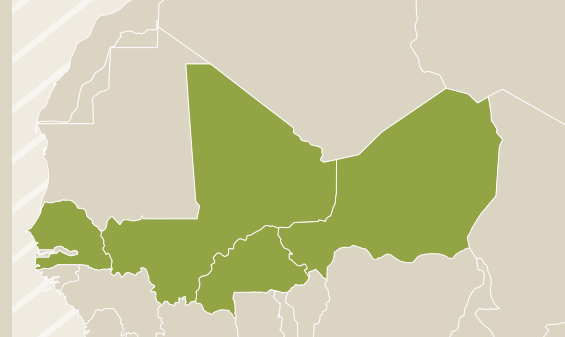
Collaborating institutions: Kansas State University, IER, CERAAS, ISRA, INRAN, ICRISAT

Latest achievements:

A second year of pearl millet trials were put into place in 2016 following multi-locational field trials in each of the four participating countries in 2015. Nearly 100 pearl millet varieties were evaluated based upon grain and fodder yield, while some new varieties were introduced. Each location found significant grain and fodder yield differences, which emphasizes the importance of environmental interactions. Students at the University of Ouagadougou characterized the population structure of the materials and found that there were strong similarities between the Mali and Burkina Faso lines which were more closely related to the Niger materials. By contrast, the lines from Senegal were very different from those from the three other countries. A monitoring visit was conducted in September 2016 in which the principal investigators in addition to researcher Desalegn Serba and Lab assistant director Nat Bascom visited trial sites in each of the four countries to facilitate a common appreciation of evaluation and performance across environments. This visit yielded several new and important insights.

RESEARCH FOR DEVELOPMENT

PROJECT UPDATES - WEST AFRICA



Assessment of pearl millet production problems in West Africa and molecular diversity analysis of pearl millet parental lines

Principal investigator: Desalegn Serba

Lead institution: Kansas State University-Hays Agricultural Research Center

Collaborating institutions: ISRA, INRAN, IER, INERA

Latest achievements:

A pearl millet nursery consisting of historical lines from the Western Kansas Agricultural Research Center and new materials from collaborators was established in Hays, Kansas. These materials were planted under a greenhouse in the winter and under field conditions during the summer growing season. Dr. Serba attended the Lab annual meeting in Senegal in March and then took part in a field monitoring tour with the West African pearl millet breeders in September to help identify program priority areas and backstop quantitative analysis of the 2015 results. Further evaluation of the lines in Hays continues.



Biological control of the millet head miner in Niger and Senegal

Principal investigator: Malick Ba

Lead institution: ICRISAT - Niger

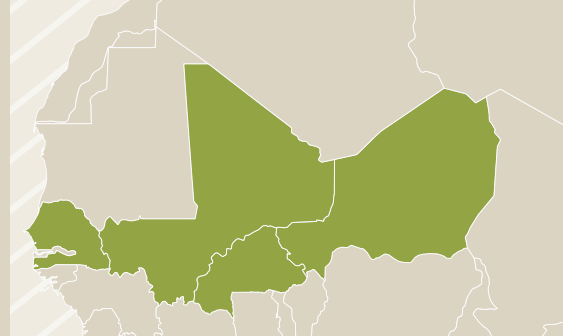
Collaborating institutions: Virginia Tech University, IPM Innovation Lab, ISRA, CERAAS, University Cheik Anta Diop de Dakar, University of Maradi, INRAN

Latest achievements:

The project has made exciting progress on rearing a second predator to control the millet head miner (MHM). This second predator targets the MHM in the egg stage, which will provide a two-pronged approach for millet head miner control. Field collection of millet head miner eggs in Niger and Senegal confirm that the predator, *Tricogrammatidae armigera*, is present and appears most promising in that it inflicted approximately 35% mortality on the MHM eggs. A colony of the egg parasitoid was established for continued research with feeding upon *Coryca cephalonica* for rearing purposes. Through this additional year of fine-tuning the rearing and release timing, it has been determined that a population of 1,600 parasitoids per five square kilometers of millet area is optimal. Community-based commercialization of parasitoids has been pilot tested at Tera in western Niger and a total of 835 parasitoid bags were sold to farmers, cooperatives and NGOs.

RESEARCH FOR DEVELOPMENT

PROJECT UPDATES - WEST AFRICA



Optimization of the seed ball technology for pearl millet, and agronomic and socio-economic evaluation in the context of smallholder farmers in Senegal and Niger

Principal investigator: Ludger Herrmann

Lead institution: University of Hohenheim

Collaborating institutions: ISRA, FAPAL (farmer organization), INRAN, Fuma Gaskiya (farmer organization)

Latest achievements:

Three seed ball devices representing varying levels of complexity and cost were developed for specific user groups, and evaluation of the usability and sustainability of the technologies was initiated. Initial results indicated that the manual seed ball construction devices are more attractive to women.

Agronomic trials were conducted based upon findings from the previous year that indicated low germination rates while farm trials were conducted in Niger. Preliminary data from these farm trials indicates a positive and significant yield benefit to the seed balls. These trials will be repeated for further data to help measure the overall impact of the technology on farmer yields.



Expanding markets for sorghum and millet farmers in West Africa through strengthening of entrepreneur processors and nutrition-based promotion of products

Principal investigator: Bruce Hamaker

Lead institution: Purdue University

Collaborating institutions: ISRA, CNRA, ITA, INRAN

Latest achievements:

A small-scale extruder was installed in Senegal and Niger and training on its use was conducted with entrepreneurs who are interested in using extruded flours in food products. These instant shelf-stable flours were tested in both thick and thin porridges in sensory studies in Niamey and rural sites (supported by the McKnight Foundation). The products were found to be at least as acceptable as the checks and some that were fortified were preferred in willingness-to-pay studies in Senegal. An evaluation of the sensory quality of products created from ten different millet varieties found significant differences in consumer acceptance. More sensory tests are expected to investigate the interaction between millet varieties and extruded products. Additionally, there is interest in extending research on extruded flours to determine how they can be used in agglomerated products such as couscous. A complementary activity has been initiated on studying how extrusion impacts anti-nutritional factors that limit the use of some locally-available nutrient dense fortificants, such as Moringa leaves. Moringa is high in iron but also has anti-nutritional compounds (such as phytic acid) and extrusion's impact on these compounds is unknown.

RESEARCH FOR DEVELOPMENT

PROJECT UPDATE - HAITI

NEW PROJECT:

Feed the Future Innovation Lab for Genomics-Assisted Sorghum Breeding

Principal investigators: Gael Pressoir, Geoffrey Morris and Edward Buckler

Lead institutions: CHIBAS - Quisqueya University, Kansas State University and Cornell University

Award amount: \$1,081,985

Project dates: October 1, 2016 - September 30, 2019

Project summary:

Globally, there is great interest in applying new genomic technologies to accelerate genetic gains in developing country breeding programs. However, these methods have not been adopted in developing country NARS due a mismatch between available genomic selection approaches and the existing operations of NARS breeding programs.

This project aims to develop genomic approaches from within a NARS breeding program to reduce barriers for adoption. Specifically, these improved genomics selection approaches will be deployed to address several key constraints for dual-purpose sorghums used by smallholders in Haiti. The targets will be improving grain yield while maintaining forage yield and quality, improving tolerance to low/high pH soils, and improving tolerance to post-emergence and post-flowering water limitation.

By designing genomics-assisted breeding approaches in a NARS, the resulting technology will be better suited for adoption by other NARS globally. The tools and resources developed in this project will facilitate adoption of genomics-assisted breeding by partner programs in West and East Africa and will be diffused globally via breeding informatics initiatives (GOBII and BMS).

Lead investigators



Gael Pressoir - CHIBAS



Geoffrey Morris - Kansas State



Edward Buckler - Cornell



Credit: Gael Pressoir

OPENING DOORS

SORGHUM AS A FOOD INGREDIENT IN ETHIOPIA'S VALUE-ADDED MARKET

Few foods define Ethiopia's cuisine like injera, a large, pancake-like bread product that is an irreplaceable part of nearly every meal. Traditionally, injera is prepared in the home by a female household member. However, with the growth of the middle class and rise in disposable income, more and more families are purchasing their injera pre-made by local vendors. This emerging market is opening new doors – and new demands – for food product development.

While teff has traditionally served as the base for injera, the usage of other grains varies by region throughout Ethiopia. Sorghum, in particular, is commonly incorporated in injera fabrication – in part, due to its affordability and availability. As a drought-resistant and heat-tolerant crop, sorghum is grown widely and is a staple crop for many smallholder farmers. However, due to its physio-chemical traits, it tends to underperform in the making of injera, which limits its use as a base ingredient and keeps the price of injera higher with the dependence on more expensive teff grain.

In an effort to improve the functionality of sorghum and expand the opportunities for its use in commercial grain-based food products, plant breeders and food scientists have teamed up under Feed the Future to test new varieties developed specifically for their high digestibility characteristics. This effort is a collaborative partnership across multiple institutions, including Texas A&M University in the United States, the University of Pretoria in South Africa and Hawassa University in Ethiopia. It is led by Joseph Awika, a food scientist at Texas A&M.

Improved highly-digestible (IHD) sorghum lines have been developed at Texas A&M and have displayed improved performance in food processing over traditional varieties. Plant breeders are working together to test these IHD lines in Ethiopian environments in order

to evaluate production constraints and opportunities for local farmers while simultaneously producing grain needed for food product testing. Meanwhile, food scientists are working with food product development labs and local women injera entrepreneurs to assess the performance of the IHD sorghum in injera and other grain-based products including hard rolls and pan bread.

The goal, say researchers, is to have sorghum varieties that carry the characteristics to produce more voluminous, tender food products while at the same time demonstrating the sensory characteristics needed for consumer acceptability. This would give injera producers and other commercial food producers greater options for incorporating sorghum blends into their products, helping to reduce costs and provide an expanded market to the millions of smallholder sorghum producers across the country. The team is already working with local injera producers to develop a sensory profile that will be used for more consumer taste testing in coming months.

But food product functionality has to be paired with strong performance in the field, so breeders continue to evaluate the strengths and constraints of producing the IHD lines in the Ethiopian growing environments. Those results will go right back into the breeding process as researchers modify the existing lines to maximize food product functionality while also optimizing them for strong production in the face of local stresses and constraints.

It is a complex problem, but thanks to multi-institutional collaboration and innovative approaches, solutions are on the way. Sorghum as a practical ingredient for commercial grain-based products offers the benefits of lower production costs for processors, while opening new market opportunities to smallholder sorghum farmers that would likely translate into increased incomes and improved livelihoods.



BUILDING THE FUTURE

TRAINING THE NEXT GENERATION OF SORGHUM SCIENTISTS

LONG-TERM TRAINING

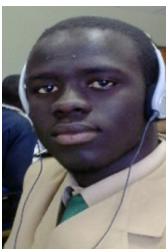
The **future** of sorghum and millet science is dependent on the scientists there to lead it. One of the **greatest impacts** that the Lab is poised to achieve will be through its **training of the next generation of scientists** dedicated to using research to improve their regions, countries and communities.



Cheikh Dieng, *Ecole National Supérieure d'Agriculture (ENSA)*
Major: Production Vegetales
Graduation Date: January 2016
Home Country: Senegal
Degree: Master's



Elisabeth Diatta, *West African Center for Crop Improvement*
Major: Plant Breeding
Graduation Date: December 2018
Home Country: Senegal
Degree: Ph.D.



Mouhamadou Diome, *ENSA Thies*
Major: Socio-economy
Graduation Date: February 2017
Home country: Senegal
Degree: Master's



Maty Diop, *University Cheikh Anta Diop*
Major: Food Science and Nutrition
Graduation Date: July 2018
Home Country: Senegal
Degree: Ph.D.



Jacques Faye, *Kansas State University*
Major: Plant Breeding & Genetics
Graduation Date: May 2019
Home Country: Senegal
Degree: Ph.D.



Gnilane Sene, *University Cheikh Anta Diop*
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BUILDING THE FUTURE

TRAINING THE NEXT GENERATION OF SORGHUM SCIENTISTS



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Home Country: Senegal
Degree: Ph.D.



Mame Fatoumata Goudiaby, *University Cheikh Anta Diop*
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Home Country: Senegal
Degree: Ph.D.



Adja Thiam, *ENSA/University of Thies*
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Omar Kendji, *University Cheikh Anta Diop*
Major: Pest Management
Graduation Date: May 2017
Home Country: Senegal
Degree: Master's



Marietou Ly, *University Cheikh Anta Diop*
Major: Pest Management
Graduation Date: August 2017
Home Country: Senegal
Degree: Master's



Baye Ndiaga Thiam, *ISFAR/University of Thies*
Major: Agricultural Engineering
Graduation Date: December 2017
Home Country: Senegal
Degree: Agricultural Engineer



Mame More Kasse, *ISFAR/University of Thies*
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Graduation Date: July 2017
Home Country: Senegal
Degree: Agricultural Engineer



Adama Sarr, *ISFAR/University of Thies*
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BUILDING THE FUTURE

TRAINING THE NEXT GENERATION OF SORGHUM SCIENTISTS



Cyril Diatta, CERAAS
Major: Plant Breeding and Genetics
Graduation Date: December 2019
Home Country: Senegal
Degree: Ph.D.



Aminata Diouf, ITA
Major: Agricultural Economics
Graduation Date: May 2016
Home Country: Senegal
Degree: Master's



Laouili Karimoune, ICRISAT - Niger
Major: Entomology
Graduation Date: December 2019
Home Country: Niger
Degree: Ph.D.



Oumou Moumouni, Abdou Moumouni University of Niamey, with Short-term Training at Virginia Tech
Major: Agricultural Economics
Graduation Date: December 2017
Home Country: Niger
Degree: Master's



Laouali Amadou, University of Maradi
Major: Entomology
Graduation Date: December 2018
Home Country: Niger
Degree: Ph.D.



Fanna Maina, INRAN
Major: Plant Breeding & Genetics
Graduation Date: December 2018
Home Country: Niger
Degree: Ph.D.



Mahamadou Maazou, University of Tahoua
Major: Socio-economy
Graduation Date: May 2017
Home Country: Niger
Degree: Master's



Hame Abdou Kadi Kadi, West Texas A&M University
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Graduation Date: July 2018
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Degree: Ph.D.

BUILDING THE FUTURE

TRAINING THE NEXT GENERATION OF SORGHUM SCIENTISTS



Moustapha Moussa, *Purdue University*
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Degree: Ph.D.



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Major: Entomology
Graduation Date: December 2017
Home Country: Niger
Degree: Master's



Rachelle Yvonne Zongo, *Universite de Ouagadougou*
Major: Seed Selection and Conservation (SELCOSE)
Graduation Date: December 2015
Home Country: Burkina Faso
Degree: Bachelor's and Master's



Benoit Ouedraogo, *University of Ouagadougou*
Major: Breeding and Conservation of Seed
Graduation Date: April 2017
Home Country: Burkina Faso
Degree: Master's



Tebila Nakelse, *Kansas State University*
Major: Agricultural Economics
Graduation Date: July 2018
Home Country: Burkina Faso
Degree: Ph.D.



Eyanawa Akata Atchozou, *CERAAS*
Major: Agronomy Breeding & Genetics
Graduation Date: July 2017
Home Country: Togo
Degree: Ph.D.

BUILDING THE FUTURE

TRAINING THE NEXT GENERATION OF SORGHUM SCIENTISTS



Charles Nwankwo, *University of Hohenheim*
Major: Soil Chemistry and Pedology
Graduation Date: June 2017
Home Country: Nigeria
Degree: Ph.D.



Nadre Gbedie, *CERAAS*
Major: Breeding
Graduation Date: March 2016
Home Country: Cote d'Ivoire
Degree: Master's



Diriba Hika Chere, *Kansas State University*
Major: Plant Breeding
Graduation Date: December 2020
Home Country: Ethiopia
Degree: Ph. D.



Loza Mengistu, *Hawassa University*
Major: Food Processing and Preservation
Graduation Date: March 2017
Home Country: Ethiopia
Degree: Master's



Kebede Dessalgn, *Haramaya University*
Major: Plant pathology/breeding
Graduation Date: December 2015
Home Country: Ethiopia
Degree: Master's



Chemeda Berhanu, *Haramaya University*
Major: Plant pathology/breeding
Graduation Date: October 2017
Home Country: Ethiopia
Degree: Master's



Alemnesh Bekele, *Haramaya University*
Major: Plant pathology/breeding
Graduation Date: June 2017
Home Country: Ethiopia
Degree: Master's



Mengistu Kassie, *Kansas State University*
Major: Agricultural Economics
Graduation Date: May 2018
Home Country: Ethiopia
Degree: Master's

BUILDING THE FUTURE

TRAINING THE NEXT GENERATION OF SORGHUM SCIENTISTS



Yemane Belaineh, *Kansas State University*
Major: Plant Breeding and Genetics
Graduation Date: December 2019
Home Country: Ethiopia
Degree: Ph.D.



Abadi Mezgebe, *University of Pretoria*
Major: Food Science
Graduation Date: July 2018
Home Country: Ethiopia
Degree: Ph.D.



Hawi Debelo, *Purdue University*
Major: Food Science
Graduation Date: September 2017
Home Country: Ethiopia
Degree: Ph.D.



Demeke Bayable, *Purdue University*
Major: Plant Pathology
Graduation Date: August 2019
Home Country: Ethiopia
Degree: Ph.D.



Tadesse Teferra, *Texas A&M University*
Major: Food Science
Graduation Date: December 2018
Home Country: Ethiopia
Degree: Ph.D.



Habte Nida, *Purdue University*
Major: Plant Breeding and Pathology
Graduation Date: June 2020
Home Country: Ethiopia
Degree: Ph.D.



Patrick Ongom, *Purdue University*
Major: Plant Genetics
Graduation Date: May 2016
Home Country: Uganda
Degree: Ph.D.



Stefanie Griebel, *Purdue University*
Major: Agronomy
Graduation Date: December 2018
Home Country: Germany
Degree: Ph.D.

BUILDING THE FUTURE

TRAINING THE NEXT GENERATION OF SORGHUM SCIENTISTS



Michael Guerci, *Virginia Tech University*
Major: Agricultural Economics
Graduation Date: May 2016
Home Country: United States
Degree: Master's



Anna Hayes, *Purdue University*
Major: Food Science and Nutrition
Graduation Date: May 2018
Home Country: United States
Degree: Ph.D.

*Students gathered at the 2016
Sorghum and Millet Innovation
Lab midterm review meetings
in Mbour, Senegal.*



BUILDING THE FUTURE

EXPANDING CAPACITY, SHARING KNOWLEDGE

SHORT-TERM TRAINING

Sharing knowledge and **expanding capacity** is a cornerstone to the Lab's research program. By training scientists, producers, processors, policymakers and others, the entire sorghum and millet communities become better equipped to extract the **full potential** of new technologies and practices under development.

TOTAL TRAININGS (2016): 35

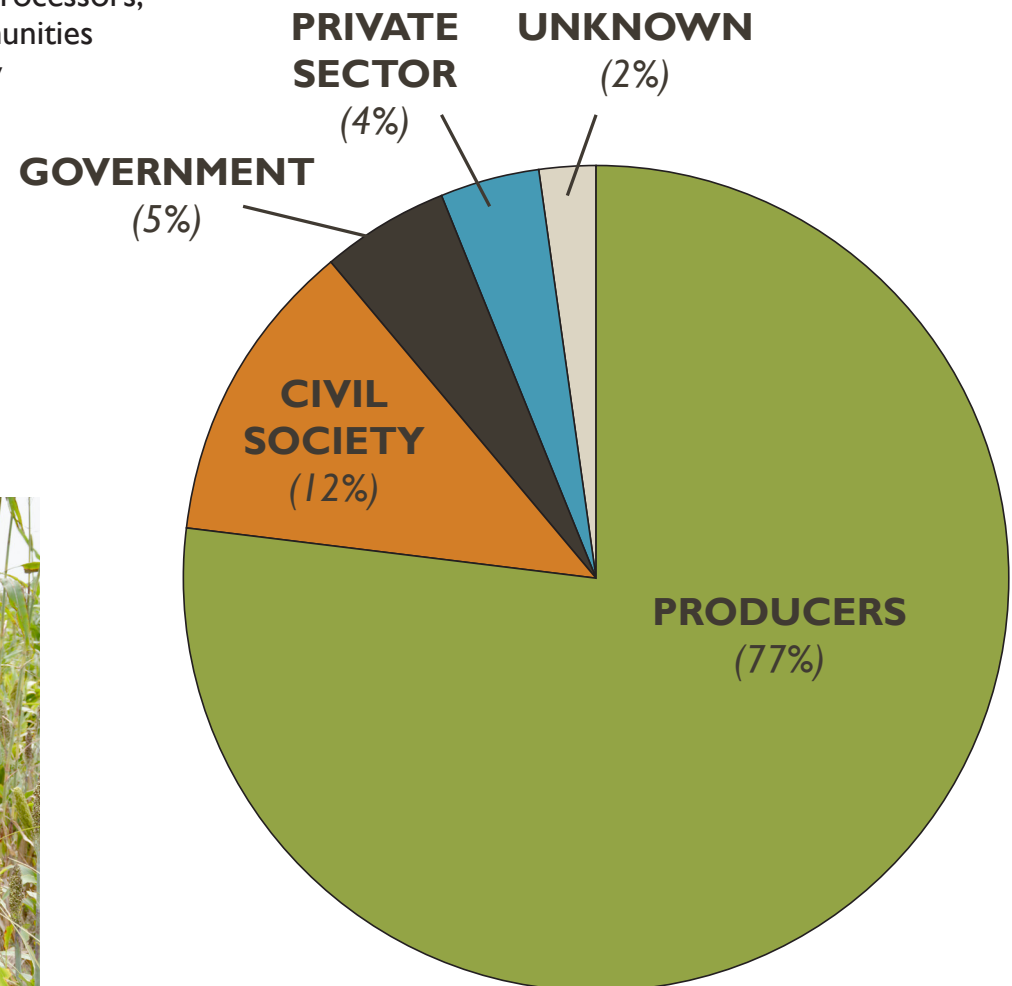
TOTAL INDIVIDUALS TRAINED (2016): 2,065



68% men



32% women



INNOVATING SOLUTIONS

TECHNOLOGY AND MANAGEMENT PRACTICE DEVELOPMENT

The Lab's research program spans the length of the sorghum and millet **value chains**, focusing on technology and management practice improvements ranging from genetic enhancement to production systems management to value-added products and market development. Those technologies and practice are in various stages of development, but all are contributing to **improving lives** and **enhancing food security**.



DUAL-PURPOSE MILLET VARIETIES

GENOMICS-ENABLED SORGHUM BREEDING



PARASITOID WASP RELEASE FOR MILLET HEAD MINER CONTROL

PEARL MILLET SEED BALLS



IMPROVED SORGHUM FOR FOOD AND PROCESSING PURPOSES



PARASITOID WASP REARING PLANS AND BUSINESS MODEL FOR MILLET HEAD MINER CONTROL

UNDER RESEARCH



NEW AND PREFERRED SORGHUM TRAITS AND VARIETIES

SORGHUM-BASED FOOD PRODUCT INNOVATION



IN FIELD TESTING



EXTRUDED SORGHUM- AND MILLET-BASED FOOD PRODUCTS

SORGHUM PEST MANAGEMENT TECHNOLOGIES



RURAL INCUBATION CENTERS FOR FOOD PRODUCT DEVELOPMENT

TRANSFER READY

ONE SCIENTIST AT A TIME

THE PROMISE OF WEST AFRICAN AGRICULTURE

When Fanna Maina looks ahead towards her career and the impact she hopes to have on Sahelian agriculture, she recalls a visit she made to a Nigerien farmer once as an intern in a rural village.

“I remember a farmer saying to me, ‘Our crops are not as productive today as they were decades ago. These days, we do not have enough grain,’” she says. “My question is this: how can we help those farmers to produce more and ensure that they have food security?”

It is that goal that has driven Maina to join the next generation of scientists in hopes of tackling issues of food security through breeding and genetics. Under funding from the Feed the Future Innovation Lab for Collaborative Research on Sorghum and Millet, Maina is currently working on her Ph.D. in agronomy at Kansas State University. As a member of the Morris Lab team, her primary area of focus is on the genetic variability of sorghum in Niger and Sub-Saharan Africa by using genomics tools to understand agronomic traits useful in crop improvement.

“Growing crops in Niger where I come from is not an easy task for smallholder farmers,” she says. “With all the constraints they face, the work that breeders are doing to develop improved varieties is also very challenging. Genetics, physiology and breeding will allow me to better understand sorghum and then develop new tools that will master the challenges of agricultural production. This work can support breeders as well as the

farmers in producing high and stable yielding varieties that perform under various constraints.”

Maina plans to continue to expand her knowledge in the new advances in genomics, which can provide researchers with accelerated tools for developing lines specifically adapted to local constraints – resulting in new varieties being made available to farmers much faster than through traditional breeding efforts.

After completing her Ph.D. program in 2019, Maina will return to Niger where she anticipates joining the national agricultural research system to advance their breeding program. Maina says that her program of study in the United States is giving her the needed skills and professional linkages to become an important player in the West Africa research community.

Being a part of that community, she says, is a key step to achieving her ultimate goal.

“I dream of serving my country and Sub-Saharan Africa,” she says. “My goal is to see those smallholder farmers produce more grain each season. I want to be part of a bigger impact of improving crop adaptation and achieving global food security.”

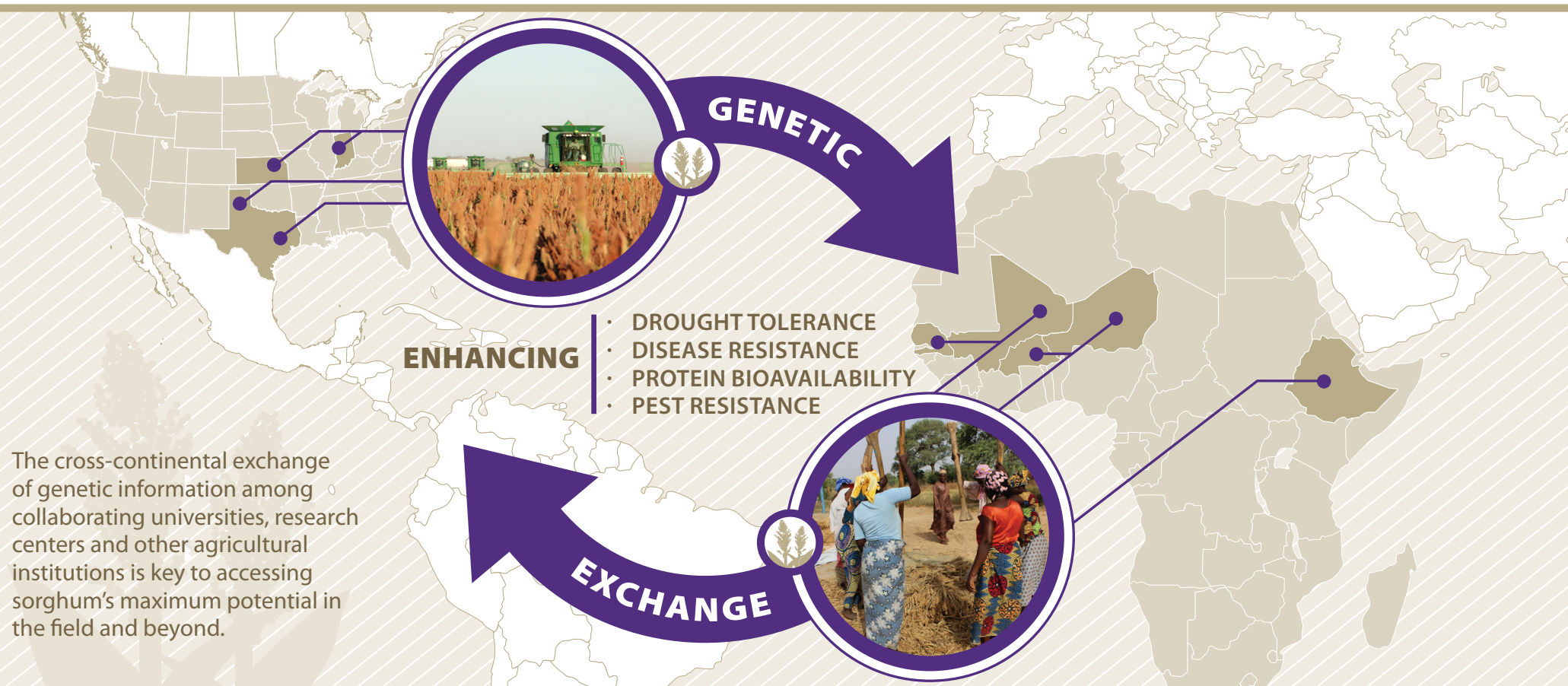
Right: Fanna examines a sorghum head at the North Farm research plot near Kansas State University as a part of her Ph.D. training program.



GLOBAL GOOD

ACHIEVING MAXIMUM POTENTIAL THROUGH WORLDWIDE PARTNERSHIPS

Sorghum is a staple crop around the world, specifically thriving in hot, dry areas, such as the African Sahel and the U.S.'s lower Midwest. This means that **farmers from across the globe** stand to benefit from **maximizing sorghum's potential**. By partnering with a long list of international institutions, researchers are gaining access to a **wealth of genetic material** that would otherwise be unavailable. This helps to ensure they are equipped with the tools they need to achieve the greatest gains.



GOING FURTHER

TACKLING CROSS-CUTTING ISSUES TO ENHANCE IMPACT



GENDER INTEGRATION

With women playing **key roles** in African agriculture, their participation, leadership and collaboration in the Lab research portfolio is crucial to ensuring that the technologies and practices under evaluation meet the needs of both men and women and that improved incomes and food security are **accessed by all**.

In order to achieve this, gender integration is held as a fundamental value across the program, and includes project-level **gender integration action plans**, efforts for **increased participation of women in science** and a commissioned field study on the links between **gender and sorghum production roles** in a variety of regions in Ethiopia.



ENVIRONMENTAL COMPLIANCE

Achieving and maintaining a **healthy research environment** is an essential cross-cutting focus. A twin-track approach supports **environmental safety through institutional capacity** and the utilization of interactive web-based monitoring tools.

The Lab's national research system partners have reinforced their institutional capacity through assigning environmental compliance focal persons at an organizational level. The Lab has also facilitated partner involvement in **regional trainings** and the development of compliance plans. These focal persons, as well as country coordinators and principal investigators, are utilizing a **web-based monitoring tool** to report visits and upload key environmental compliance support documents.



NUTRITION BY DEMAND

RESEARCH AND TECHNOLOGY RESPOND TO MARKET DEMAND FOR CONVENIENT, NUTRITIOUS FOODS

Couscous, degue, thiakry, lakhou. Sorghum and millet are the key ingredients to countless West Africa staple dishes. The dishes come in many forms and are called a variety of names, but they are all rooted in years of rich history and are key to the food security of millions of people living in some of Africa's most challenging climates.

While these foods are an important source of nutrition for West Africans of all ages and backgrounds, they are very often prepared using traditional methods that are labor-intensive and require multiple hours of preparation each day, a responsibility that typically falls to the women of the household. With increasing urbanization and disposable income, as well as a deeper understanding and demand for nutritionally-balanced diets, these food products are seeing a market-driven revolution.

Collaborative efforts between three international organizations – the McKnight Foundation and the Feed the Future Innovation Labs for Sorghum and Millet (previously INTSORMIL) and Food Processing and Post-Harvest Handling – in partnership with numerous national research programs and local initiatives have served as the driver for a new wave of business and nutritional opportunities.

Initially launched to help build greater demand for locally-produced grains and provide more reliable income for West African smallholder farmers, the initiative concentrates on the creation of entrepreneurial opportunities and networks for local women to produce traditional food products that are packaged, easy-to-prepare and ready for purchase by local consumers.

"Focusing on local markets can help reduce transaction costs and lead to higher benefits for our target smallholder farmers," says Bettina Haussmann, West African liaison scientist for the McKnight Foundation. "Sometimes the processing units will make contracts directly with small-holder farmers to purchase high-quality grain at a good price, which can enhance the income security of the farmer."

Both rural and urban models of this initiative have been

established, and have included food product development and testing according to local contexts, says Timothy Dalton, director of the Feed the Future Innovation Lab for Collaborative Research on Sorghum and Millet. In addition to evaluating preferences for food product type and processing method, testing has also been conducted around the fortification of grain-based products with locally available, highly nutritious ingredients such as moringa and baobab with encouraging results. Initial screenings have shown that consumers not only appreciate the flavor and texture of the fortified products, but are also willing to pay a premium for them.

"In consumer testing, we find that instant millet-based food products are rated equal, and even sometimes better, than traditional products," says Bruce Hamaker, food scientist at Purdue University and lead researcher on the food product development initiative. "The testing has also shown that consumers are willing to pay more for the instant products, especially if they are fortified."

It is the market-driven demand for these products that makes them so promising, both as an income-generator for local entrepreneurs and farmers, but also as a source for improved nutrition for individuals and families.

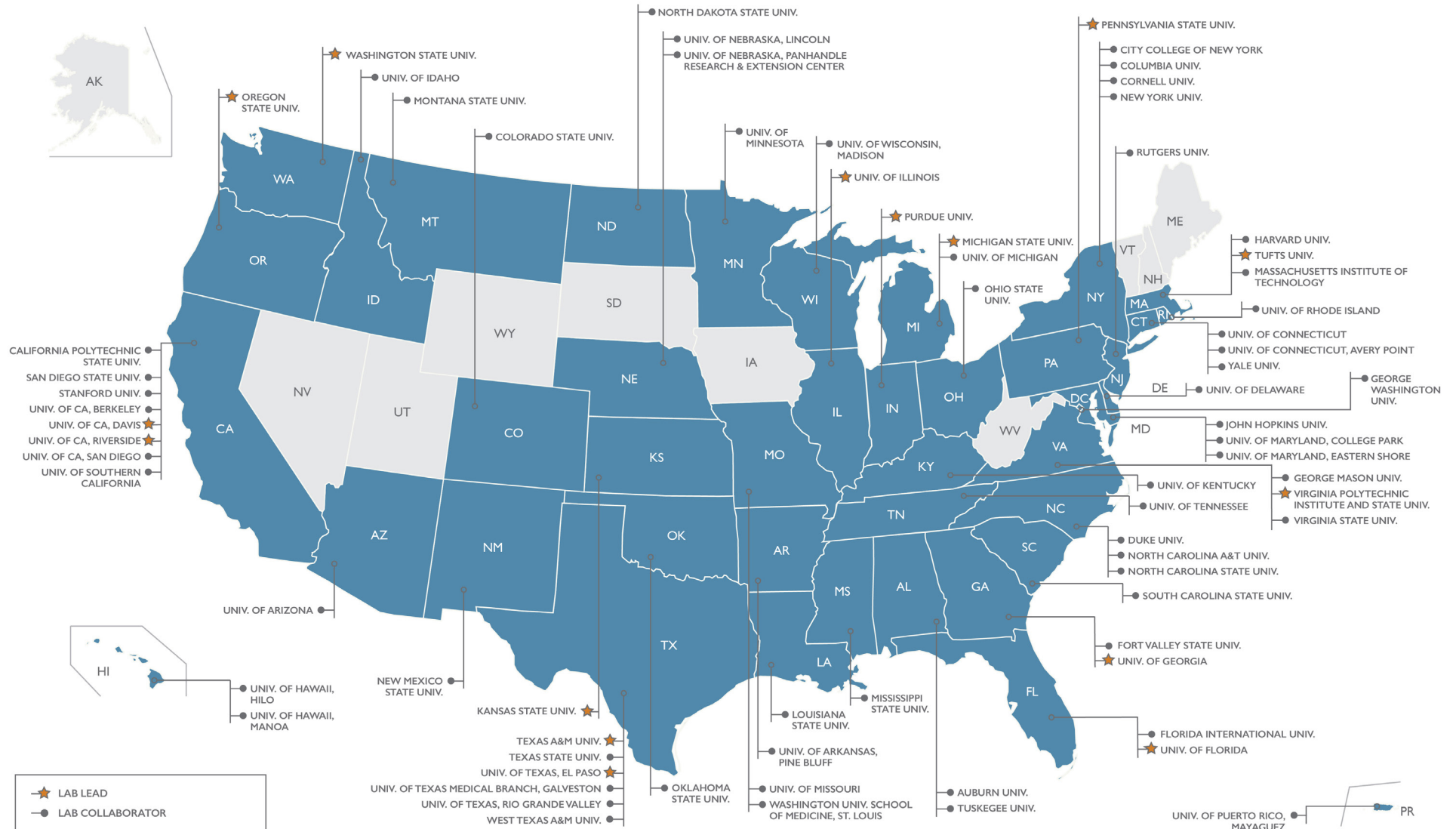
"The market appeal of these products is sustainable because they are being developed according to local food preferences and the availability of local ingredients," says Dalton. "This interaction between supply and demand means that it does not rely upon donor funding, logistical support or external supply."

And that, Dalton emphasizes, is key to the long-term success and impact of this initiative.

"What is needed now is continued support and empowerment to create more of these products that are in demand," he says. "In both urban and rural areas, there are efficiency gains to be made through mechanization and the formation of more processors and cooperatives. Both strategies will increase the supply of locally-made foods to meet the rising demand."



FEED THE FUTURE INNOVATION LABS HELP FIGHT GLOBAL HUNGER



The Feed the Future initiative partners with universities throughout the world: This map represents U.S. universities that are part of the Feed the Future Innovation Lab network. For more information and updates, visit www.feedthefuture.gov or follow on Twitter @FeedtheFuture.

For more information, contact:

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