



# FEED THE FUTURE

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



## Feed the Future Innovation Lab for Legume Systems Research Fiscal Year 2023 Annual Report October 1, 2022 – September 30, 2023

Version: FINAL



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## A. Management Entity Information

The Feed the Future Innovation Lab for Legume Systems Research (hereafter Legume Systems Innovation Lab), Cooperative Agreement No. 7200AA18LE00003, was awarded to Michigan State University (MSU) for a five-year period as Prime of the Leader with Associate (LWA) award, on August 23, 2018. On August 23, 2023, MSU received a 5-year extension. The Management Entity (ME) is housed at MSU's College of Agriculture and Natural Resources, East Lansing, MI.

The ME includes the following:

- Barry Pittendrigh, Director
- John Medendorp, Deputy Director
- Doreen Gordon, Financial Officer
- David DeYoung, Program Manager
- Jan Fierro, Communications Manager
- Jane Payumo, Monitoring and Evaluation (M&E) Specialist
- Ndiaga Cisse, West Africa Regional Coordinator

## B. Technical and Advisory Committee Information

### Technical Management and Advisory Committee (TMAC)

The Legume Systems Innovation Lab's Technical Management and Advisory Committee (TMAC) monitors projects and advises the Legume Systems Innovation Lab ME on strategic planning and monitors projects. The ME consults with the TMAC on emerging issues and technologies, strategies for building sustainable institutional capacity and achieving development impacts, and program management approaches.

In FY 2023, members who served on the TMAC are:

- Jeff Alwang, TMAC Chairperson, Virginia Polytechnic Institute and State University (Virginia Tech), Virginia, USA
- Robert Easter, University of Illinois Urbana-Champaign, Illinois, USA
- Jeff Ehlers, Bill and Melinda Gates Foundation, Washington, USA
- Louis Jackai, North Carolina Agricultural, and Technical State University, North Carolina, USA
- Rebbie Harawa, International Crops Research Institute for the Semi-Arid Tropics, Nairobi, Kenya
- Greg Varner, former Michigan Bean Commission's research director, Michigan, USA
- Robin Buruchara, Alliance Bioversity International Center for Tropical Agriculture (CIAT), Nairobi, Kenya
- Joyce Mulila-Mitti, former Plant Protection Officer of Food and Agriculture Organization (FAO), Lusaka, Zambia
- Juan Osorno, Lead PI project representative, North Dakota State University, North Dakota, USA
- Batiemo T Benoit Joseph, West Africa Co-PI representative, Institute of the Environment and Agricultural Research (INERA), Ouagadougou, Burkina Faso
- Virginia Chisale, Southern Africa Co-PI representative, Department of Agricultural Research Services (DARS), Lilongwe, Malawi

The USAID Agreement Officer's Representative (Daniel Bailey) is an ex-officio member of the TMAC.

After the awarding of research and capacity development projects in the three Areas of Inquiry (AOI) outlined in the cooperative agreement, the principal investigators (PIs) of the awarded projects elected the final three TMAC members listed above as project representatives.

## **The Legume Industry Consultative Council (LINCC)**

The Legume Industry Consultative Council (LINCC) is comprised of private sector legume experts who provide stakeholder input to the directors of the Legume Systems Innovation Lab to ensure the Management Entity (ME), its projects, and research outputs remain critically relevant to the legume private sector for growth and competitiveness. Biannual meetings serve to make the ME and projects aware of emerging opportunities or challenges in the private legume sector, foster public-private sector interactions that afford legume stakeholders opportunities to deepen links with the legume industry, and explore opportunities for messaging regarding the benefits of legumes, including nutrition and consumption.

The LINCC is led by Michigan Bean Commission Executive Director Joe Cramer. In FY 2023, members who served on the LINCC are:

- Dee Richmond, US Dry Bean Council
- Tim McGreevy, US Dry Pea and Lentil Council
- Jeff Rumney, US Dry Pea and Lentil Council
- Andi Woolf-Weibye, Idaho Bean Commission
- Randy Duckworth, Global Pulse Federation
- Rebecca Bratter, US Dry Bean Council
- Thoric Cederstrom, US Dry Bean Council
- Cindy Brown, Chippewa Valley Bean
- Katia Sambin, Chippewa Valley Bean
- Charles Wachsmuth, Chippewa Valley Bean
- Todd DeKryger, Gerber/Nestle
- Jeff Van Pevenage, Columbia Grain
- Mark Thompson, Trinity Super Foods Zambia

## C. Geographical Foci

The Legume Systems Innovation Lab's current subaward projects are implemented in Benin, Burkina Faso, Senegal, Niger, Nigeria, Ghana, Mali, Malawi, Mozambique, and Zambia (Figure 1).



Figure 1: Legume Research Innovation Lab actively works in 10 countries in sub-Saharan Africa in FY2023

## D. List of Program Partners

The Legume Systems Innovation Lab works with the following U.S. partners and international partners in FY2023:

### United States

California State University, Chico\*  
Georgia State University\*  
Kansas State University  
Michigan Bean Commission  
North Dakota State University  
Ohio State University  
Purdue University  
University of California, Riverside\*  
University of Nebraska-Lincoln  
University of Puerto Rico, Mayaguez\*  
Virginia Tech University  
\*Denote Minority Serving Institutions (MSI)

### Benin

International Institute of Tropical Agriculture (IITA) -Benin  
University of Abomey-Calavi

### Burkina Faso

Institut de l'Environnement et du Recherches Agricoles (INERA)  
Universite Norbert Zongo

### Ghana

Africa RISING/IITA  
University of Ghana, Legon  
Crops Research Institute  
Council for Scientific and Industrial Research – Savanna Agricultural Research Institute (CSIR-SARI)

### Kenya

Alliance Bioversity International and CIAT – Kenya

### Malawi

Alliance Bioversity International and CIAT – Malawi  
Department of Agricultural Research Services (DARS)  
Lilongwe University of Agricultural and Natural Resources (LUANAR)

### Mali

Université des Sciences Sociales et de Gestion de Bamako  
Institut d'Economie Rurale  
Observatoire des Marchés Agricoles  
Alliance Bioversity International and CIAT – Malawi  
Tradeline Corporation Group Ltd  
Catholic Development Commission in Malawi (CADECOM)

### Mozambique

Instituto de Investigação Agrária de Mozambique (IIAM)

### Nepal

Nepal Agricultural Research Council

### Niger

L'Institut National de la Recherche Agronomique (INRAN)

University of Maradi

Université Abdou Moumouni de Niamey

### Nigeria

University of Ilorin

Bayero University in Kano

ICRISAT - Nigeria

Kwara State University

Ahmadu Bello University

Kwame Nkrumah University of Science and Technology

### Rwanda

Alliance Bioversity International and CIAT – Rwanda

### Sénégal

Institut Sénégalais de Recherches Agricoles (ISRA)

ISRA/Centre d'Etude Regional Pour l'Amélioration l'Adaptation a la Secheresse (CERAAS)

ISRA/ Bureau d'Analyse Macroéconomique (BAME)

University of Thies

Ecole Nationale Supérieure d'Agriculture (ENSA)

Agence Nationale de Conseil Agricole et Rural (ANCAR)

Université Cheikh Anta Diop de Dakar (UCAD)

RESIMAO

Universite Assane Seck

### Uganda

Alliance Bioversity International and CIAT – Uganda

### Zambia

University of Zambia

Zambia Agriculture Research Institute (ZARI)



## E. Acronyms

AOI	Area of Inquiry	HICD	Human and Institutional Capacity Development
AOR	Agreement Officer's Representative	IA	Initial Activity
BHEARD	Borlaug Higher Education for Agricultural Research and Development	ICT	Information and Communication Technology
BIFAD	Board for International Food and Agriculture Development	ICTA	Instituto de Ciencias y Tecnología Agrícolas
BNF	Biological nitrogen fixation	IEE	Initial Environmental Examination
CBNP	Community-Based Neem Production	IER	Institut d'Economie Rurale
CGIAR	Consortium of International Agriculture Research Centers	IL	Innovation Lab
CIAT	International Center for Tropical Agriculture	INERA	Institut de l'Environnement et du Recherches Agricoles du Burkina Faso
CLA	Collaborative, Learning and Adapting	INRAN	L'Institut National de la Recherche Agronomique du Niger
Co-PI	Co-Principal Investigator	IPM	Integrated Pest Management
CR	Commissioned Research Project	IR	Intermediate results
CSIR-SARI	Council for Scientific and Industrial Research – Savanna Agricultural Research Institute	ISRA	Institut Sénégalais de Recherches Agricoles
DDL	Development Data Library	ISRA/CERAAS	ISRA Centre d'Etude Régional pour l'Amélioration de l'Adaptation a la Sécheresse
DEC	Development Experience Clearinghouse	KM	Kaleidoscope Policy Model
DMP	Data Management Plan	KNUST	Kwame Nkrumah University of Science and Technology
EMMP	Environmental Management and Mitigation Plan	KWASU	Kwara State University
FAO	Food and Agriculture Organization	LINCC	Legume Industry Consultative Council
FGD	Focus Group Discussions	LUANAR	Lilongwe University of Agricultural and Natural Resources
FTFMS	Feed the Future Monitoring System	LWA	Leader with Associate Award
FY	Fiscal Year	MABC	Marker-assisted backcrossing
GFSS	Global Food Security Strategy		
HC	Host Country		

MAGIC	Multi-parent advanced generation inter-cross	SI Toolkit	Sustainable Intensification Assessment Framework
MARS	Marker-assisted recurrent selection	SNP	Single Nucleotide Polymorphisms
MAS	Marker-assisted selection	TMAC	Technical Management Advisory Committee
ME	Management Entity	TOC	Theory of Change
M&E	Monitoring and Evaluation	UCR	University of California Riverside
MSP	Multi Stakeholder Platform	USAID	United States Agency for International Development
MSU	Michigan State University	USDA	United States Department of Agriculture
NARS	National Agricultural Research Systems	USG	United States Government
NIFA	National Institute of Food and Agriculture	VGG	Venture Garden Group
OPI	Organizational Performance Index	ZARI	Zambia Agriculture Research Institute
PABRA	Pan-Africa Bean Research Alliance		
PERSUAP	Pesticide Evaluation Report and Safer Use Action Plan		
PI	Principal Investigator		
PLC	Product Life Cycle		
PMP	Performance Management Plan		
PPP	Public-private sector partnerships		
PVS	Participatory Variety Selection		
RMA	Rapid Markets Analysis		
RoC	Record of Compliance		
RRT	Resilience Resource Team		
SAWBO	Scientific Animations Without Borders		
SAWBO <i>RAPID</i>	SAWBO Responsive-Adaptive-Participatory Information Dissemination Scaling Program		



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## I. Executive Summary

The Feed the Future Innovation Lab for Legume Systems Research concluded Phase 1 and received an extension for Phase 2 expanding its research portfolio of competitive grants and commissioned projects in FY2023. During the first five years the Management Entity (ME):

- provided degree training for 65 individuals at numerous higher-learning institutions globally. Of the 65 students, 37 were women. The Legume Systems Innovation Lab supported eight doctoral students, and 48 master's degree students from 10 countries studying at 23 higher education institutions in Africa and the U.S.,
- provided short-term training to 8,315 individuals in legume systems-related activities, and the program's 120 researchers worked in 13 countries with 62 institutional partners on 30 research and development projects resulting in 32 technologies and 171 publications and presentations.

During FY2023 the ME:

- executed the Nepal USAID Mission lentil project which saw the creation of a public/private supported multi-stakeholder platform (MSP), the creation of 15 educational animations to increase the knowledge and awareness of Nepal lentil farmers including a dedicated website (<https://nepal.sawbo-animations.org/>) and deployment program including national television and social media that reached over 20 million Nepalese,
- Concluded research on five seed-grant winning recipients selected through the grant writing workshop, with the first peer-reviewed publication in Nature's Scientific Reports titled, "*Physico-functional and nutritional characteristics of germinated pigeon pea (*Canjanus cajan*) flour as a functional food ingredient*" (<https://www.nature.com/articles/s41598-023-43607-8>),
- led over 100 global legume researchers in a four-day convening event held in Livingstone, Zambia with featuring 67 presentations on program activities and a poster session including 15 posters,
- actively participated in the USAID Innovation Lab Council Director meetings in both Nairobi, Kenya and Washington D.C. including organization of a participant field day activity to a smallholder farm in Muranga County Kenya to observe how innovations depicted in SAWBO animations are integrated in real time,
- and the program supported 9 cross cutting theme activities highlighting the collaboration of 4 minority serving institutions (MSIs) expanding the reach and depth of global legume researchers collaborating through a systems approach.

## II. Focus Country Key Accomplishments

### A. Benin



In Benin, the Legume Systems Innovation Lab Phase I funded three research and development projects: (1) integrated pest management (IPM) research to reduce cowpea losses caused by pests, (2) the Cowpea Atlas to equip actors at all points in the cowpea value chain with available data and knowledge to improve production and efficiency, and (3) Measuring the Impact of Digital Technologies on Informal Traders Productivity to understand the adoption and usage of digital technologies among legume traders.

The IPM project spearheaded by IITA-Benin aims to encourage the widespread adoption of immediate, tangible, cost-effective, and scalable IPM solutions (e.g., biological control agents and biopesticides) against the insect pests of cowpea. Implementing these IPM solutions can be a vital part of sustainable agriculture

and efforts to combat the impacts of climate change on food security and the environment. One of these solutions is the release of parasitoids *Liragathis javana* and *Phanerotoma syleptae*, which have been shown to decrease the pod borer (*Maruca vitrata*) populations – an important result corroborated by the project’s collaborators and global experts in IPM solutions from Niger (INRAN), Burkina Faso (INERA), and Nigeria (Kwara State University). A critical part of this project was training and local capacity building to integrate this solution into existing IPM systems and practices for wider adoption in farming communities in target countries. This project actively pursued this initiative and ensured that there was balanced participation across groups (gender, youth, and marginalized groups). Through the Farmer Interface Application (App), this project also capitalized on the use of modern digital technologies for pest management. The project introduced this App inclusive of all farming groups and user types (low and high digital literacy) to effectively monitor pod borers in the field. This initiative helped inform farmers on timely interventions on pesticide use. Both the biological control agent and FFA contribute to climate change mitigation and adaptation by reducing the carbon footprint of agriculture, conserving biodiversity, enhancing ecosystem resilience, and promoting sustainable and climate-resilient agricultural practices.

Researchers from University of Abomey Calavi in Benin participated in the Cowpea Atlas project, led by the Institut Sénégalais de Recherches Agricoles in Senegal. This project aims to empower communities, governments, and organizations with the information they need to make informed decisions to support the cowpea value chain in Benin, Nigeria, Niger, Senegal, and other West African countries. This project specifically aims to offer a one-stop shop source of cowpea data and information for many stakeholders in these countries. In collaboration with its data partners, the project identified the various data sources for cowpeas and identified data gaps, including data collection strategies to address these gaps. The project also collected datasets related to the (1) status and diversity of the cowpea workforce disaggregated by gender, expertise, and affiliation; (2) inventory of cowpea genetic resources, including information on source and availability; (3) production constraints; (4) value chain actors including processors, markets, and consumers; and (5) crop production including harvested area, yield and quantities produced for the four countries. Data sources included national and local surveys and FAO statistics. Data collection efforts were also supported by training and outreach and a series of consultations with local institutions and researchers from partner countries so they could contribute, collect, and promote data-driven decision-making for the cowpea sector. These datasets were analyzed and visualized through interactive dashboards and will soon be available online on the Legume Lab website for a broader reach.

Researchers from Georgia State University and IITA Benin found that the average number of monthly transactions per traders is 11.6, the proportion of traders who use digital technologies is 51%, the proportions women in the legumes value chain is 81%, and their average age is 45.8 years old. The data also report their levels of education, years of experience in the legumes business, and business size. Interestingly, more than half of the respondents (52%) do not have a formal training or education, about half of them employ 6 to 9 employees (49.9%), and most of the respondents have more than 10 years of experience (90%).

## B. Burkina Faso



In Burkina Faso, the Legume Systems Innovation Lab Phase I funded research and development projects on cowpea breeding, integrated pest management (IPM), and the effects of input subsidy policies on the legume farming landscape.

Researchers at the Institut de l'Environnement et du Recherches Agricoles and the University of California Riverside collaborated to develop high-yielding and market-preferred cowpea varieties that are locally available and utilized by women, men, and young farmers and value-chain actors. The project team was focused on enhancing traits of the following varieties in Burkina Faso: 1) Komcalle (striga, macrophomina, and aphid resistance, seed size); 2) Nafi (striga, macrophomina, and aphid resistance, seed size); and 3) Tiligre (striga, macrophomina, and aphid resistance, seed

size).

INERA researchers also collaborated with researchers from the International Institute of Tropical Agriculture to encourage the widespread adoption of immediate, tangible, cost-effective, and scalable IPM solutions (e.g., biological control agents and biopesticides) against insect pests of cowpea. Implementing these IPM solutions can be a vital part of sustainable agriculture and efforts to combat the impacts of climate change on food security and the environment. One of these solutions is the use of neem extract, which has been shown to decrease pod borer (*Maruca vitrata*) infestation - an important result observed in farmer-led experimental fields in Bala, Dinderesso/Nasso, Bama, and Farok-Ba, Burkina Faso. Neem-treated plots decreased *Maruca* infestation by 16% and increased yield by 37% compared to unsprayed fields.

Additionally, researchers at Michigan State University and Universite Norbert Zongo studied how input subsidy policies change the cowpea farming landscape. The design and implementation of the input subsidy programs can influence the demand and supply of fertilizer as well as the macroeconomy. This project aims to improve understanding of the input subsidy program in Sahelian countries of West Africa: Burkina Faso and Mali within a broader policy context and to draw lessons on what might be done to improve it and help foster an enabling agricultural policy environment for the cowpea farmers and households in these countries. The project team made some very important findings, including:

- 1) Households receiving a fertilizer subsidy allocate more land to targeted crops (rice, maize, and cotton). They allocate less land to cowpea as either a main crop or intercrop and grow a less rich portfolio of crop species diversity.
- 2) There is a positive effect of increased crop diversity on farms on the diet diversity of women in smallholder farm families relative to that shown in previous literature. Findings underscore the continued importance of farm production for farm family livelihoods while the local markets are developed.

Training and local capacity building for the next generation of scientists and researchers from Burkina Faso were also actively pursued this fiscal year. A total of 11 students (three Ph.D., five Master's, and three Bachelor's; and mostly women) matriculated at the University of Ouagadougou, Université Aube Nouvelle, Université Joseph Ki Zerbo, Université Saint Thomas D'Aquin, University of Dedougou, and University Nibert Zongo. Program and degree concentration for these students span across disciplines, including entomology, applied economics, agronomy, seed conservation, and plant breeding. More than half (6/11) of the students from Burkina Faso completed their degrees.

The projects also facilitated short-term training events on various topics including new cowpea breeding materials, protocols, and production practices. A diverse group of participants from the farming groups, government, women-owned small and medium enterprises, and civic society in Burkina Faso participated in these events.

### C. Senegal



In Senegal, the Legume Systems Innovation Lab Phase I funded five research and development projects focused on: (1) genetic trait improvement of commercially demanded cowpea varieties; (2) a shrub-intercropping system for enhanced cowpea production; (3) quantifying the scale and scope of nutritious cowpea products; (4) dual benefits evaluation of cowpea varieties on feed and fodder yields; and (5) design of the Cowpea Atlas to equip actors at all points in the cowpea value chain with available data and knowledge to improve production and efficiency.

Researchers at the Institut de l'Environnement et du Recherches Agricoles and the University of California Riverside collaborated to develop high-yielding and market-preferred cowpea varieties that are locally available and utilized by women, men, and young farmers and value-chain actors. The project team was focused on enhancing three varieties in Senegal: (Pakau, Sam, and Yacine) with select traits, e.g., macrophomina and flower thrips resistance, seed size).

Researchers from the Institut Sénégalais de Recherches Agricoles (ISRA) also collaborated with Ohio State University researchers on an innovative crop management system called “optimized shrub system” that takes advantage of native shrubs in rural Senegal in West Africa. The project team evaluated if these shrubs can bio-irrigate adjacent cowpea plants during drought or allow a second crop at the beginning of the dry season. This system once fully evaluated and scaled in target areas in Senegal offers to improve overall farming system performance: production efficiency, risk management, resilience, inclusiveness, profitability, acceptability, and improved household nutrition.

Additionally, ISRA researchers partnered with Kansas State University researchers to develop and evaluate agronomic management strategies for the sustainable intensification of dual-purpose cowpea into smallholder agro-pastoral farming systems across the peanut basin in Senegal. These cowpea varieties offer a versatile and sustainable source of food and forage (animal feed). The project team used a multidisciplinary, farming systems approach based on the Sustainable Intensification Assessment Framework (SIAF) ([www.sitoolkit.com](http://www.sitoolkit.com)) and a participatory research model (i.e., “mother-baby trial”) to collect robust biophysical farming systems and socioeconomic data to identify enabling conditions for technology extrapolation and barriers to adoption that can guide future research and scaling.



Further, ISRA researchers led the implementation of the Cowpea Atlas project, in partnership with other researchers from Benin, Nigeria, and Niger. This project aims to empower communities, governments, and organizations with the information they need to make informed decisions to support the cowpea value chain in Benin, Nigeria, Niger, Senegal, and other West African countries. This project specifically aims to offer a one-stop shop source of cowpea data and information for many stakeholders in these countries. In collaboration with its data partners, the project identified the various data sources for cowpeas and identified data gaps, including data collection strategies to address these gaps. The project also collected datasets related to the (1) status and diversity of the cowpea workforce disaggregated by gender, expertise, and affiliation; (2) inventory of cowpea genetic resources, including information on source and availability; (3) production constraints; (4) value chain actors including processors, markets, and consumers; and (5) crop production including harvested area, yield, and quantities produced for the four countries. Data sources included national and local surveys and FAO statistics. Data collection efforts were also supported by training and outreach and a series of consultations with local institutions and researchers from partner countries so they could contribute, collect, and promote data-driven decision-making for the cowpea sector. These datasets were analyzed and visualized through interactive dashboards and will soon be available online on the Legume Lab website for a broader reach.

Training and local capacity building for the next generation of scientists and researchers from Senegal were also actively pursued this fiscal year. A total of 17 master's students (about half are women) matriculated at the University Gaston Berger, Cheikh Anta Diop University of Dakar, and the University of Thies. Degree concentration for these students spans across disciplines, including agronomy, plant production, soil sciences, agricultural engineering, seed technology, agricultural economics, and cropping systems. About half (8/17) of the Senegalese students completed their degrees.

The projects also facilitated short-term training events, which were attended by farmers, researchers, and students.

## D. Niger



In Niger, the Legume Systems Innovation Lab Phase I funded three research and development projects: (1) integrated pest management (IPM) research to reduce cowpea losses caused by pests; (2) promotion of trade integration in regional legume markets with mobile technology; and (3) the Cowpea Atlas to equip actors at all points in the cowpea value chain with available data and knowledge to improve production and efficiency. L'Institut National de la Recherche Agronomique (INRAN) led the implementation of these projects in Niger. The Innovation Lab also received USAID Niger Mission Buy-In to address (a) Integrated Pest Management (IPM) Solutions and (b) Improved Varieties of Cowpea as priority areas.

The IPM project aims to encourage the widespread adoption of immediate, tangible, cost-effective, and scalable integrated pest management (IPM) solutions (e.g., biological control agents and biopesticides) against insect pests of cowpea. Implementing these IPM solutions can be a vital part of sustainable agriculture and efforts to combat the impacts of climate change on food security and the environment. One of these solutions is the use of neem extract, which has been shown to decrease pod borer (*Maruca vitrata*) infestation- an important result observed in on-station experiments at INRAN Maradi. Neem-treated plots resulted in marginally better yield compared to those treated with chemical pesticides. In FY2023, the community-based neem production units set up in Niger produced more than 6,539 neem tea bags ready for sale to local farmers, co-ops and traders. Over the

life of the project community based production units, comprised of mostly women, produced 15,989. Neem tea bags. Animated videos were launched to encourage the larger community to venture into neem tea bag production. Training and local capacity building for the next generation of scientists and researchers from Niger were also actively pursued this fiscal year to support the IPM project. A total of 7 students (1 PhD, 3 Master's, and 3 Bachelors) matriculated at the University of Maradi. Program and degree concentration for these students span across disciplines, including agriculture, socioeconomics, and entomology. The PhD and three MSc students are female.

A mobile phone-based app, KasuwaGo, launched first in Nigeria, is now available in Niger. KasuwaGo aims to bridge connection gaps in the informal farming sector using modern digital and mobile applications to boost food production. It connects Niger producers (legume farmers), and traders (wholesalers and retailers) across various geographic locations to have effective communication about the legume produce and other crops they wish to buy or sell, at agreed prices. This App also captures user feedback to rate the quality of services provided and products received and available in multiple languages.

The Cowpea Atlas project aims to empower communities, governments, and organizations with the information they need to make informed decisions to support the cowpea value chain in Benin, Nigeria, Niger, Senegal, and other West African countries. This project specifically aims to offer a one-stop shop source of cowpea data and information for many stakeholders in these countries. In collaboration with its data partners, the project identified the various data sources for cowpeas and identified data gaps, including data collection strategies to address these gaps. The project also collected datasets related to the (1) status and diversity of the cowpea workforce disaggregated by gender, expertise, and affiliation; (2) inventory of cowpea genetic resources, including information on source and availability; (3) production constraints; (4) value chain actors including processors, markets, and consumers; and (5) crop production including harvested area, yield and quantities produced for the four countries. Data sources included national and local surveys and FAO statistics. Data collection efforts were also supported by training and outreach and a series of consultations with local institutions and researchers from partner countries so they could contribute, collect, and promote data-driven decision-making for the cowpea sector. These datasets were analyzed and visualized through interactive dashboards and will soon be available online on the Legume Lab website for a broader reach.

## E. Nigeria



In Nigeria, the Legume Systems Innovation Lab Phase I funded three research and development projects: (1) integrated pest management (IPM) research to reduce cowpea losses caused by pests; (2) promotion of trade integration in regional legume markets with mobile technology; and (3) the Cowpea Atlas to equip actors at all points in the cowpea value chain with available data and knowledge to improve production and efficiency.

The International Institute of Tropical Agriculture-led IPM project in partnership with Kwara State University aims to encourage the widespread adoption of immediate, tangible, cost-effective, and scalable IPM solutions (e.g., biological control agents and biopesticides) against insect pests of cowpea. Implementing these IPM solutions can be a vital part of sustainable agriculture and efforts to combat the

impacts of climate change on food security and the environment. One of these solutions is the release 45,000 individuals of *Phanerotoma syleptae* and 8,000 individuals of *Liragathis javana* in early June on wild vegetation at the margins of the Falgore Forest Reserve south of Kano, Nigeria. This was the first critical release close to the most important cowpea production area in northern Nigeria. These two parasitoids have been shown to

decrease the pod borer (*Maruca vitrata*) populations – an important result corroborated by researchers from Kwara State University and project’s collaborators and global experts in IPM solutions from Niger (INRAN), and Burkina Faso (INERA).

A mobile phone-based app, KasuwaGo, launched in Nigeria in FY2021, now has more than 13,000 users. KasuwaGo aims to bridge connection gaps in the informal farming sector using modern digital and mobile applications to boost food production. It connects producers (legume farmers), and traders (wholesalers and retailers) across various geographic locations to have effective communication about the legume produce and other crops they wish to buy or sell, at agreed prices. This App also captures user feedback to rate the quality of services provided and products received and available in multiple languages. A private sector firm signified interest in further growing the App, its users, and services in Nigeria. In FY2023 the app was transferred to private sector partner Novus Agro.

Researchers at the Ahmadu Bello University in Nigeria partnered with CERAAS/ISRA (project lead) along with other researchers from Benin, Senegal and Niger to implement the Cowpea Atlas. This project aims to empower communities, governments, and organizations with the information they need to make informed decisions to support the cowpea value chain in Benin, Nigeria, Niger, Senegal, and other West African countries. This project specifically aims to offer a one-stop shop source of cowpea data and information for many stakeholders in these countries. In collaboration with its data partners, the project identified the various data sources for cowpeas and identified data gaps, including data collection strategies to address these gaps. The project also collected datasets related to the (1) status and diversity of the cowpea workforce disaggregated by gender, expertise, and affiliation; (2) inventory of cowpea genetic resources, including information on source and availability; (3) production constraints; (4) value chain actors including processors, markets, and consumers; and (5) crop production including harvested area, yield and quantities produced for the four countries. Data sources included national and local surveys and FAO statistics. Data collection efforts were also supported by training and outreach and a series of consultations with local institutions and researchers from partner countries so they could contribute, collect, and promote data-driven decision-making for the cowpea sector. These datasets were analyzed and visualized through interactive dashboards and will soon be available online on the Legume Lab website for a broader reach.

Training and local capacity building for the next generation of scientists and researchers from Nigeria were also actively pursued this fiscal year. Two Ph.D. students from the University of Ilorin and Bayero University are participating in short-term visiting scholar programs at Michigan State University.

Seed funding support was also provided to Nigerian researchers. Dr. Toyin Ajibade from the University of Ilorin, received funding support for her project “Enhancing Gender Inclusivity in Legume Value Chain with Market-Based ICT Support Services.”

## F. Ghana

Due to a request by the USAID Ghana Mission to streamline international development activities in-country, communications from U.S. based programs, and reduce transaction costs, the Legume Systems Innovation Lab coordinated the management of legume research activities with Africa RISING. Researchers at the Council for Scientific and Industrial Research – Savanna Agricultural Research Institute and the University of California Riverside collaborated to develop high-yielding and market-preferred cowpea varieties that are locally available and utilized by women, men, and young farmers and value-chain actors. The project team was focused on enhancing traits of the following varieties in Ghana: Apagbaala (aphid resistance, striga resistance, seed size); Soo-Sima (striga resistance, seed size, earliness); and Zaayura Pali (striga resistance, earliness) The successful development and commercialization of new, improved cowpea varieties are



expected to grow the nation’s cowpea sector. In FY2023, the National Variety Release and Registration Committee recommend five advanced lines for release. The National Seed Council approved two advanced lines (spMAGIC006 released as Kanton-Gongdaa and spMAGIC012 released as Awudu Benga) with the remaining three under review at the next council meeting.

Training and local capacity building for the next generation of scientists and researchers from Ghana were also actively pursued this fiscal year. A total of 3 students - two Master’s (on-going), and one Bachelor’s (completed) with agriculture-related degrees matriculated at top universities in Ghana.

Seed funding support was also provided to Ghanain researchers. Selorm Yaotse Dorvlo of University of Ghana, Legon, received funding support for his project, “Design and performance evaluation of a small-scale cowpea combine harvester,” and Richard Atinpoore Atuna of University for Development Studies received funding support for his project, “Improving the nutritional qualities and utilization of cowpea (*Vigna unguiculata*) and pigeon pea (*Cajanus cajan*) using household-level processing methods.”

### G. Mali



In Mali, the Legume Systems Innovation Lab Phase I funded two research and development projects focused on: (1) studying the scale and scope of nutritious cowpea products in local markets and (2) how input subsidy policies change the legume farming landscape.

Investigators from Université des Sciences Sociales et de Gestion de Bamako, Mali partnered with researchers from Michigan State University (MSU, project lead) and Université de Thiès, Senegal to generate a quantitative inventory of cowpea products supplied and demanded in local market hubs, record product, vendor, and market characteristics, and collect shopper data in lean and abundant seasons to test the effectiveness of market-based incentives on consumer behavior. Researchers found both rural and urban Malians are highly dependent on stable

crops and that Mali is still very early in the dietary transformation process. While cowpea has often been characterized as a “women’s crop, the project found men are more likely than women to plant cowpea and tend to plant larger intercropped areas. However, women are more likely to grow cowpea than other crops and appear to earn more on average from selling the harvest from their individual plots than men. These results imply that gender roles need to be clearly understood to ensure interventions are designed for the right audiences.



Researchers at MSU and Economie de la Filière, Institut d’Economie Rurale, Mali partnered to assess how input subsidy policies change the cowpea farming landscape. The design and implementation of the input subsidy programs can influence the demand and supply of fertilizer as well as the macroeconomy. This project aims to improve understanding of the input subsidy program in Sahelian countries of West Africa: Burkina Faso and Mali within a broader policy context and to draw lessons on what might be done to improve it and help foster an enabling agricultural policy environment for the cowpea farmers and households in these countries. The project team made some very important findings, including:

- 1) Households receiving a fertilizer subsidy allocate more land to targeted crops (rice, maize, and cotton). They allocate less land to cowpea as either a main crop or intercrop and grow a less rich portfolio of crop species diversity.
- 2) There is a positive effect of increased crop diversity on farms on the diet diversity of women in smallholder farm families relative to that shown in previous literature. Findings underscore the continued importance of farm production for farm family livelihoods while the local markets are developed.

Training and local capacity building for the next generation of scientists and researchers from Mali were also actively pursued this fiscal year. A total of five master’s students (three male and two female) matriculated at the Université des Sciences Sociales et de Gestion de Bamako or Institut Polytechnique Rural de Formation et de Recherche Agricole. Program and degree concentration for these students span across disciplines, including agricultural economics, geomatic land use planning, and management. Three students completed their degrees.

#### H. Malawi



In Malawi, the Legume Systems Innovation Lab Phase I funded three research and development projects focused on the (1) development and commercialization of bruchid-resistant common dry beans; (2) multi-stakeholder platforms (MSP) for bean seed production and supply systems; and (3) development and commercialization of consumer-preferred processed legume-based products.

Researchers from the Department of Agricultural Research Services in Malawi partnered with lead researchers of the bruchid-resistance project from the University of Zambia, and investigators from the Instituto de Investigação Agrária de Mozambique and North Dakota State University to develop high-yielding and market-preferred common varieties (*Phaseolus vulgaris*) for commercialization in Malawi, Zambia and

Mozambique. These varieties are bruchid-resistant, locally available, and utilized by women, men, young farmers, and value-chain actors. The team field-tested and identified promising lines with bruchid resistance ready for progression to the next stage (release and commercialization), further investment, and public-private sector partnerships (PPP).

Researchers of the Alliance of Bioversity International - CIAT led a collaborative project focused on a rapid market assessment of legume-based processed foods and assessing the superiority of value-added legume-based products and processing technologies. This project also utilized a PPP model and involved the participation of international researchers from Malawi: Feed the Future Agriculture Diversification (AgDiv) Activity, and Lilongwe University of Agriculture and Natural Resources; Zambia: National Bean Program,

ZARI-Misamfu Regional Research Station, University of Zambia, and Trinity Super Foods; and U.S.: Virginia Tech. The project has identified legume-based foods that can be promoted for high-added-value market development.

Malawian researchers also partnered with lead researchers from the Alliance of Bioversity International – CIAT for another project that focused on expanding a decentralized, private sector-led platform from the traditional centrally monopolized formal seed delivery system. The integration of the bean seed systems in MSP resulted in an increased seed supply and sales of farmer and consumer-demanded varieties and reduced time of farmers’ varietal uptake.

Seed funding support was also provided to Malawian researchers. Madalitso Chambukira of Lilongwe University of Agriculture and Natural Resources received funding for his research titled, “Gendered impact of market participation on household’s nutritional outcomes: Panel data evidence from Pigeon peas, Cowpeas and Common beans producers in rural Malawi.”

## I. Mozambique



In Mozambique, the Legume Systems Innovation Lab Phase I funded the development and commercialization of bruchid-resistant common dry beans. The Instituto de Investigação Agrária de Mozambique partnered with the University of Zambia, Department of Agricultural Research Services in Malawi, and U.S. researchers at North Dakota State University collaborated to develop high-yielding and market-preferred common varieties (*Phaseolus vulgaris*) that are bruchid-resistant, locally available and utilized by women, men, and young farmers and value-chain actors. The team field-tested and identified promising lines with bruchid resistance developed and multiplied in Zambia ready for progression to the next stage (release and commercialization), further investment, and public-private sector partnerships.

Training and local capacity building for the next generation of scientists and researchers from Mozambique who can support the country’s plant breeding initiatives were also actively pursued this fiscal year. One female graduate student from Mozambique matriculated for a master’s in plant breeding and seed systems at the University of Zambia.

## J. Zambia



In Zambia, the Legume Systems Innovation Lab Phase I funded two research and development projects focused on the development and commercialization of (1) bruchid-resistant common dry beans; and (2) consumer-preferred processed legume-based products.

The University of Zambia, in partnership with the Instituto de Investigação Agrária de Mozambique (IIAM), Department of Agricultural Research Services (DARS) in Malawi, and U.S. researchers at North Dakota State University (NDSU) implemented a project focused on developing high-yielding and market-preferred common varieties (*Phaseolus vulgaris*). These varieties are bruchid-resistant and are locally available and utilized by women, men, young farmers, and value-chain

actors. The team field-tested and identified promising lines with bruchid resistance ready for progression to the next stage (release and commercialization), further investment, and public-private sector partnerships (PPP). The project also facilitated short-term training events to create awareness among farmers on the bruchid resistance breeding program. Training and local capacity building for the next generation of scientists and researchers from Zambia who can support the country's plant breeding initiatives were also actively pursued this fiscal year. Two students from Zambia matriculated for a master's in plant breeding at the University of Zambia and North Dakota State University.

Researchers of the Alliance of Bioversity International-CIAT led a collaborative project focused on a rapid market assessment of legume-based processed foods and assessing the superiority of value-added legume-based products and processing technologies. This project also utilized a PPP model and involved the participation of international researchers from Zambia: National Bean Program, ZARI-Misamfu Regional Research Station, University of Zambia, and Trinity Super Foods; Malawi: Feed the Future Agriculture Diversification Activity, and Lilongwe University of Agriculture and Natural Resources; and U.S.: Virginia Tech. The project has identified legume-based foods that can be promoted for high-added-value market development.

Seed funding support was also provided to Zambian researchers. Swivia Moonga Hamabwe from the University of Zambia received funding for her research titled, "Identification of Faster Cooking Yellow Common Bean Genotypes with Non-darkening Seed Coat and Superior Nutritional Profile."



### III. Research Program Overview and Structure

As a Leader With Associate (LWA) award, the Legume Systems Innovation Lab research program is based upon competitively awarded projects and carefully selected commissioned research projects. The Legume Systems Innovation Lab addresses Global Food Security Strategy (GFSS) objectives around sustainability in agricultural systems, resilience among people and systems, and food security and nutrition, especially among women and children. The Legume Systems Innovation Lab seeks to enable research to enhance the multifunctionality of legumes in production and market systems, offering scientifically validated innovations, including methods of research, policy recommendations, and technologies that benefit farmers, traders, processors, and consumers in Feed the Future priority areas. The initial geographical foci of the research and capacity development efforts were Central America and West Africa. Due to USAID funding restrictions on new activities in the northern triangle of Central America during FY2019, no new projects were funded in Central America between FY2019 and FY2022. The Legume Systems Innovation Lab, in consultation with the TMAC and USAID AOR, pivoted from Central America to supporting commissioned research projects in the Southern African countries of Malawi, Mozambique, and Zambia.

The Legume Systems Innovation Lab pursues strategic collaborative research with research-intensive institutions, host country governmental and nongovernmental organizations, and private sector partners. Research is based on three AOIs:

- AOI 1: Integration of legumes into sustainable smallholder farming systems and agricultural landscapes.
- AOI 2: Integration of legumes within local/regional market systems, including trade.
- AOI 3: Analysis of sociocultural and/or economic motivators or barriers to legume utilization at various stages and scales within production and market systems.

The Legume Systems Innovation Lab also provides graduate research and training and other forms of capacity development to support sustainable research systems in the host countries and institutions of funded projects. The results will be increased transfer, dissemination, and access to new knowledge and technologies via people, institutions, and countries with improved capacity to sustain agricultural research systems able to produce and disseminate their own technological advances.

### IV. Theory of Change and Impact Pathways

Figure 2 illustrates the Legume System Innovation Lab's approach to implementing adaptive and results-based management with its theory of change (TOC) as the guiding framework to achieve desired impact. The TOC begins with a set of critical inputs. These inputs include the time and resources that the ME, in partnership with USAID, and local and international partners representing the public and private sectors, networks of researchers, and the global legume community, contribute to the program. The Collaborate, Learn, and Adapt (CLA) approach, combined with prior needs assessments, risk management strategies, and USAID resources, makes key program activities possible. Strategic investments in targeted research inquiries and balanced legume systems research portfolio will result in gender- and youth-responsive, nutrition-sensitive outputs strengthening local community resilience. These outputs will fill gaps in the innovation pipeline of the legume systems in key parts of the world and produce game-changing technologies (e.g., advanced cowpea breeding lines with desirable traits), knowledge and management practices (e.g., pest control), or evidence-based research findings (e.g., improved market system strategies for producers, buyers, consumers, and other players driving economic activity in the market). Through effective outreach initiatives, in partnership with relevant actors, including the public and private sectors, donors, and local governments, and complemented by strategic program activities, these outputs can then be transferred to end-users (e.g., farmers and consumers) in the legume systems value chain to encourage and enhance adoption. The CLA feedback loops of collaboration, learning, and adoption, with recognition of culture, process, and resources, are essential to producing cross-cutting intermediate results (IRs).

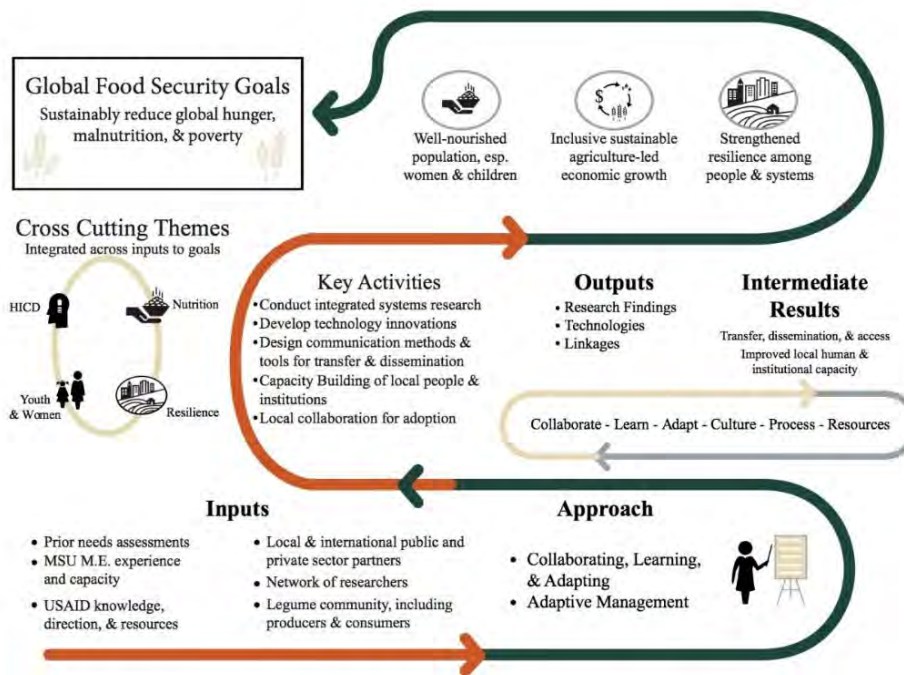


Figure 2: A Generalized View of the Legume Systems Innovation Lab's Theory of Change.

TOCs that identify the goals, preconditions, requirements, assumptions, and interventions for all funded projects were also designed in consultation with the Principal Investigators (PI) and the project teams. Measurable metrics (Feed the Future performance indicators and custom indicators) of success were also designed as a roadmap to monitoring, management, and evaluation at the project and program levels. The Legume Systems Innovation Lab's Legume Resource and Reporting Hub was modified and enhanced to enable collection, organization, monitoring, and reporting of data and information supporting relevant indicators. Highlights of accomplishments and initial successes tied to TOC and impact pathways are presented in the succeeding pages.

Integration of CLA into programming of the Legume Systems Innovation Lab's activities continues this year and efforts were focused on:

1) Collaborating (*Is the Legume Systems Innovation Lab collaborating with the right partners at the right time?*) - all Areas of Inquiry advocate for collaboration with the right partners to promote research synergy and cutting-edge global collaboration with locally relevant research.

2) Learning (*Is Legume Systems Innovation Lab addressing strategic issues and critical questions related to the program and sharing those answers to its stakeholders for their learning?*) - The Legume Systems Innovation Lab actively maintains its website, monthly e-newsletter, and social media accounts, and Legume Resource Reporting Hub, to encourage knowledge and information sharing among its PIs and partners. Additionally, Management Entity staff meet bi-weekly with its AOR, quarterly with USAID Missions in host countries, and semi-annually and annually with project PIs and LINCC to identify the critical questions and address strategic issues.

3) Adapting (*Is the Legume Systems Innovation Lab using the information it gathers through collaboration, consultation and learning for insights, decision making and adjustments as needed?*) -During the competitive grant cycle in 2019, and again through quarterly communication with USAID Missions, the ME heard the request of Missions to help improve the competitiveness of host country researchers in applying for research grants. The ME adapted its

HICD strategy to include the Grant Writers Workshop and Starter Grant Competition in FY2022 to further develop the capacity of host country researchers to apply for and be awarded research grants. The ME also learned from other Innovation Labs and adapted its strategy to increase engagement of MSI-based researchers. In FY2022, three new MSI received subaward grants from the Legume Systems Innovation Lab after a call for proposals designed to engage MSI-based researchers.

4) Enabling Conditions – Regular communications and consultations between ME, PIs, across project teams, and project partners enable CLA. These are supported with digital transformation initiatives and enabling tools (e.g., collaborative suites, communication, project management, intranet platforms, and other digital tools) to ensure that CLA efforts continue, especially even during a global pandemic. Recent discussion to overcome counter incentives to CLA, especially organizational culture and HICD efforts are also underway.

## V. Research Project Reports

### A. Area of Inquiry I:

#### **AOI 1.1: Development of Market-Driven Improved Cowpea Varieties for West Africa using Mature-Markers**

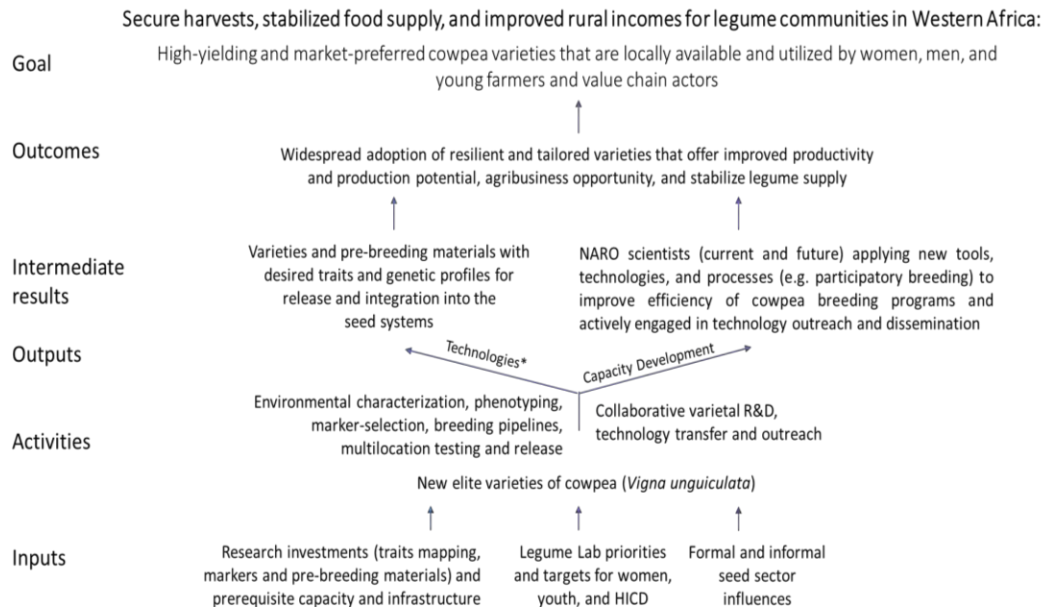
**Locations:** **Ghana** (Bawku Municipal, Binduri, Garu, Tempene, Bawku West, Sissala East, Sissala West, Tolon, Kumbungu, Mion, and Sanaregu) **Burkina Faso** (Ouagadougou, Fada, Tenkodogo, Koudougou, and Bobo-Dioulasso) **Senegal** (Diourbel, Thies, Louga, and Niore)

**Description:** Cowpea is a highly nutritious legume crop vitally important to food security in the Sudano-Sahel of West Africa, especially for women and children. However, typical smallholder farmer yields are 10-20% of potential, mainly due to insect pests, pathogens, parasites, and drought. This project focuses on Ghana, Senegal, and Burkina Faso, three countries in the West Africa cowpea production region that provide a broader regional representation of West Africa cowpea production systems.

Cowpea downstream breeding utilizes previously discovered Single Nucleotide Polymorphisms (SNP) marker haplotypes linked to target traits. A suite of marker-trait pairs through indirect selection develops improved versions of elite varieties and superior lines. Traits targeted to improve current varieties are tolerance/resistance to aphids, thrips, *Macrophomina*, and *Striga*, together with drought tolerance and preferred grain quality (large seed, rough seedcoat, and seed color) with advanced breeding population lines selected for market-driven preferred grain types.

At University of California Riverside, researchers utilize marker resources and advanced breeding lines for overlapping trait targets with the West Africa targets cowpea and advance dry grain novel market classes of breeding lines. Research outputs and associated capacity development will increase pulse productivity via yield gain, thereby promoting dietary nutritional value and the livelihoods of women and youth, and resilience by increased household incomes. Capacity strengthening includes graduate degree training in cowpea breeding and genetics and short-term annual training of NARS scientists in molecular breeding.

## Theory of Change and Impact Pathways(s):



This TOC begins with a goal of secured harvests, stabilized food supply, and improved rural incomes for legume communities in Western Africa. The project “**Development of Market-Driven Improved Cowpea Varieties for West Africa using Mature-Markers**” contributes to this goal by encouraging widespread adoption of resilient and tailored varieties that offer improved productivity and production potential, agribusiness opportunity and stabilized legume supply. This can be achieved through the availability of breeding pipelines with desirable traits, and NARO scientists applying new tools, technologies, and processes (e.g. participatory breeding) to improve efficiency of cowpea breeding programs and are actively engaged in technology outreach and dissemination. A critical part of this project is the availability of stable genetic pre-breeding materials, precise and efficient cowpea breeding and seed production programs, capacity of the formal seed systems, and linkages to the farming communities. This project capitalizes on previously discovered molecular markers linked to target traits, and cowpea lines ready for multi-location testing and scaling, and strategic global and regional partnerships established to implement the project activities. Success will depend on critical inputs, including research investments, prerequisite research capacity and infrastructure, priorities and targets by the Legume Lab, and formal and informal seed sector influences.

**Collaborators:** Philip Roberts, University of California Riverside (UCR), USA. Bao-Lam Huynh, University of California Riverside, USA. Francis Kusi, CSIR-SARI, Ghana. Moussa Diangar, ISRA, Senegal. Benoit Joseph Batiemo, INERA, Burkina Faso. Timothy Close, University of California Riverside, USA.

**Achievements:** In **Ghana** the National Variety Release and Registration Committee recommend five advanced lines for release. The National Seed Council approved two advanced lines (spMAGIC006 released as Kanton-Gongdaa and spMAGIC012 released as Awudu Benga) with the remaining three under review at the next council meeting.

Their seeds were sent to UCR for SNP genotyping together with 8 varieties developed from other USAID projects in **Burkina Faso** (Gourgou, Issa Sosso, Makoyin, Neerwaya, Teeksongo and Yipoussi) and Senegal (3006 and 5464). On the marker-assisted backcrossing (MABC) objective, BC2F3 progenies were planted for single plant selections in Ghana and **Burkina Faso**. Progenies derived from BC2F2 intercrosses were also SNP genotyped to select for lines homozygous at stacked QTLs in Ghana. They included two lines, one derived from the recurrent parent Apagbaala and fixed for aphid-resistance QTLs (two from IT97K-556-6 via CB77, one from SARC 1-57-2), and the other also derived from Apagbaala and fixed for the aphid-resistance QTL from IT97K-556-6 via CB77 and two QTLs from spMAGIC10 (one QTL for striga resistance and one QTL for large seed). Additionally, one BC2F1 population (Tiligre //Tiligre/CB77) was planted at UCR for genotyping, and BC2F2 seeds fixed for two aphid-resistance QTLs from CB77 were sent to **Burkina Faso** in June 2023 for evaluation of aphid resistance. In **Senegal**, data analysis of advanced lines from multi-site and participatory trials have identified seven best performing MARS and spMAGIC lines for further evaluations. Seeds of these lines are being multiplied in the field for evaluation trials in the rainy season. In the USA, 200 pounds of breeder seeds of the aphid-resistant blackeye variety CB77 have been produced for submission to

the UC Davis Foundation Seed Program. These seeds were planted by the University of California Davis Foundation Seed Program for Foundation seed production in summer 2023. New MABC versions of CB5 with resistance to aphid and fusarium wilt diseases were tested in a replicated trial at the UC Kearney Agricultural Research and Extension Center in summer 2023.

**Capacity Development:** In Ghana, two MSc students (both male) and one bachelor's student (female) supported by the project are nearing completion of their degree. The project trained three the young scientists (1 female) on research methodology. The training covered a range of topics such as recognizing and defining a research problem, developing a research design, responsible research and innovation, research methods and data collection techniques, validity, reliability, rigor of data collection and analysis, research ethics, open access and open innovation. The training was organized by Centre for Innovation and Entrepreneurship (CIE) under CSIR College of Science and Technology (CCST).

In Burkina Faso ,degree training for one master's degree (1 female) and two bachelor's degree (1 female) students was completed, and two PhD (1 female) students were near completion. Training workshops on seed production were also provided to farmers in May and July 2023.

In Senegal, two master students (1 female) completed their thesis defense, five bachelor's degree (2 female) students graduated, and one master student (female) is in progress.

**Lessons Learned:** SNP genotyping identified off types in most seed samples of the 13 released and candidate varieties sent from host countries emphasizes a need for future seed purification prior to integration into seed systems in host countries.

#### **Presentations and Publications:**

Roberts, P., Huynh, B., Clark, N., Light, S., Long, R., Matthews, W., & Leinfelder-Miles, M. (March 2023). 2022 Progress Report and 2023 Proposal Blackeye Varietal Improvement. Presentation at California Dry Bean Advisory Board Meeting, Stockton, CA, USA

Awuku, F. (February 2023). Application of marker systems to add traits to elite Ghanaian cowpea lines. Presentation at Legume Systems Innovation Lab Global Convening, Livingstone, Zambia

Roberts, P., Huynh, B., Close, T., Light, S., Long, R.... (August 2023). Blackeye varietal improvement: update on new pest-resistant varieties. Presentation at UC Dry Bean Field Day, Davis, California, USA.

Huynh BL, Clark NE, Light SE, Long R, Leinfelder-Miles M, Kusi F, Batiemo TBJ, Cisse N, Diangar M, Matthews WC, Duong T, Kang HP, Ehlers JD, Close TJ, and Roberts PA. (February 2023). Collaborative Marker-Assisted Breeding to Accelerate Varietal Improvement of Cowpea for West Africa and the USA. Presentation at Legume Systems Innovation Lab Global Convening, Livingstone, Zambia

Attamah, P. (February 2023). Field performance test of improved lines in support of the variety release process. Presentation at Legume Systems Innovation Lab Global Convening, Livingstone, Zambia

Huynh, B., Batiemo, B., Poda, L., Tignegre de la Salle, J., Sawadohgo, N., Ouedraogo, J., & Sawadogo P. (February 2023). Geographical distribution and genetic variability of *Alectra vogelii* (Benth) in Burkina Faso. Presentation at Legume Systems Innovation Lab Global Convening, Livingstone, Zambia.

Diangar, M. M. (February 2023). Phenotyping and selection of advanced cowpea lines from MARS, MAGIC and super-MAGIC populations based on grain yield and nutrients and farmer preferences in Senegal. Presentation at Legume Systems Innovation Lab Global Convening, Livingstone, Zambia.

Huynh BL, Stangoulis JCR, Vuong TD, Nguyen HT, Duong T, Boukar O, Kusi F, Batiemo BJ, Cisse N, Diangar MM, Awuku FJ, Attamah P, Crossa J, Pérez-Rodríguez P, Ehlers JD, Roberts PA. (under review) Quantitative trait loci and genomic prediction for grain sugar and mineral concentrations of cowpea [*Vigna unguiculata* (L.) Walp.]. *Scientific Reports*. (Peer Reviewed)

Huynh BL, Dahlquist-Willard RM, Ploeg AT, Yang M, Thaoxaochay L, Kanter J, Brar S, Paz J, Qaderi S, Singh H, Duong T, Dinh H, Kang HP, Matthews WC, De Souza A, Bhatia A, Ke H, Ehlers JD, Roberts PA (under review) Registration of Four Pest-Resistant Long Bean Germplasm Lines. *Journal of Plant Registrations*. (Peer Reviewed)

Batiemo, B. (February 2023). Update on the Market-Driven Improved Cowpea Varieties project activities in Burkina Faso. Presentation at Legume Systems Innovation Lab Global Convening, Livingstone, Zambia.

Huynh BL, Stangoulis JCR, Vuong TD, Nguyen HT, Duong T, Boukar O, Kusi F, Batiemo TBJ, Cisse N, Diangar M, Crossa J, Ehlers JD, Close TJ, Roberts PA (February 2023) Variation and Genetic Dissection of Grain Sugar and Mineral Concentrations of Cowpea. Presentation at Legume Systems Innovation Lab Global Convening, Livingstone, Zambia.

## **AOI 1.2: Science-Driven and Farmer-Oriented Insect Pest Management for Cowpea Agro-Ecosystems in West Africa**

**Locations:** Benin (IITA-Station), Niger (Maradi and Zinder), Burkina Faso (Bama and Banfora), Nigeria (Kwara)

**Description:** Cowpea is one of the most important grain legumes in West Africa, but its production remains threatened by insect pests which can severely reduce grain yields. To minimize their impact in cowpea cropping systems in Burkina Faso, Niger, and Nigeria and redress yields, this project is developing and deploying climate-resilient, environmentally friendly, and economically profitable IPM approaches and tools that are easily implementable by women and men farmers. The project is currently scaling two technologies: biological control agents and neem-based bio-pesticide for impact in select pilot farms.

The community-based production of bio-pesticides mostly relies on women and youth groups and this productive activity offers livelihood and income opportunities for these groups. The project's pest control approach focuses on alternatives to chemical insecticide use. It promotes the use of both parasitic wasps<sup>1</sup> as biocontrol agents and the seeds from the neem tree. The approaches benefit women cowpea farmers who have much less access to conventional pesticides. Additionally, the reduction of pesticides use has a significant potential to improve the health of women, who are more engaged in cowpea production and farming. This sustainable approach is also particularly attractive to youth who are more concerned about climate change and global warming. In the project's farmer capacity development and educational

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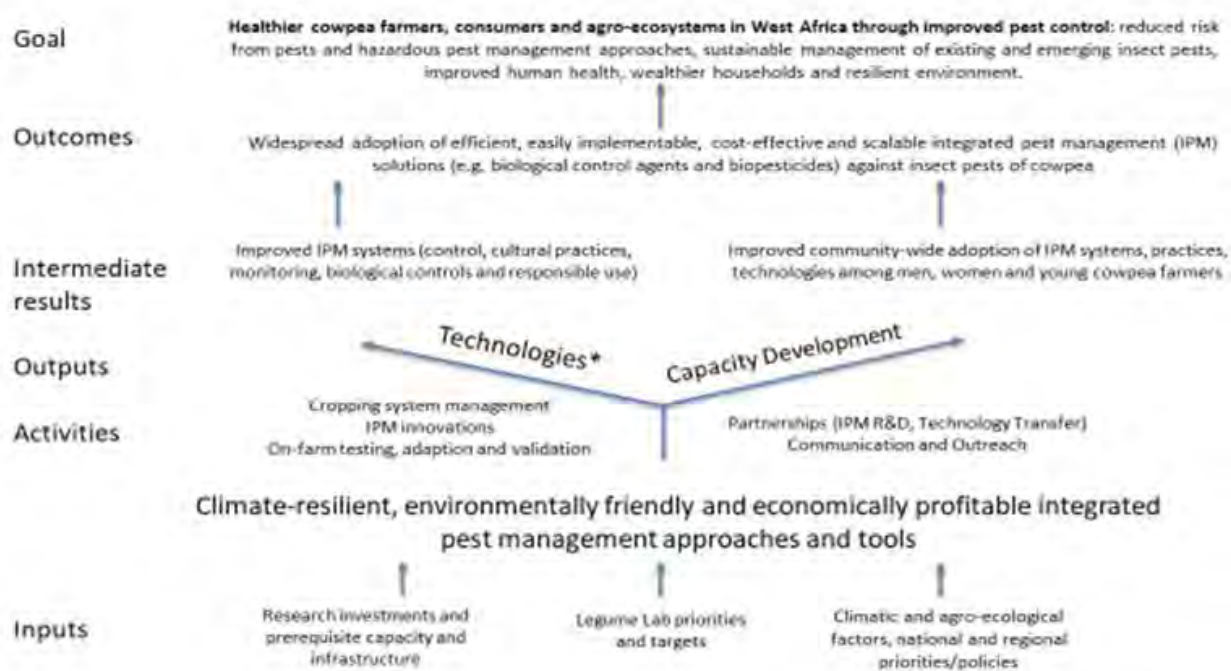
<sup>1</sup> Taxonomy and population genetic studies have recently clarified that the legume pod borer (*Maruca vitrata*) which is a major cowpea pest in Africa, is in fact a foreign species from tropical Asia, and might have invaded Africa long before modern entomology was invented. The most important aspect of this finding is that, while in Africa there are very limited native biocontrol agents, which are poorly adapted to the pod borer, in Asia there is quite a wide range of efficient and specific hymenopteran parasitoids which can keep the pod borer population under control. Therefore, biocontrol efforts simply re-establish this natural balance by introducing into Africa the most promising parasitoids which are co-existing with the pod borer in its native habitat range in tropical Asia.

The introduction of biological control agents (BCA) into ecosystems follows strict international norms to ensure they are safe for the environment and human population. These norms include independent consultant environmental impact studies, adherence to all governmental phytosanitary procedures and regulations in the target countries, development and deployment of standard operating procedures for handling, rearing, testing, introducing, and releasing BCA's into the environment, monitoring of released BCA's, and development and deployment of educational programs to train farmers and inform communities where BCA's are released.



approaches, every effort is made to develop effective deployment strategies for women and youth, such that they have increased access to improved strategies for safe and sustainable cowpeas pest management.

### Theory of Change and Impact Pathways(s):



This TOC begins with a goal of healthier cowpea farmers, consumers and agro-ecosystems in West Africa through improved pest control. The project "Science-driven and farmer-oriented insect pest management for cowpea agro-ecosystems in West Africa" contributes to this goal by encouraging widespread adoption of immediate, tangible, cost-effective and scalable integrated pest management (IPM) solutions (e.g. biological control agents and biopesticides) against insect pests of cowpea. This can be achieved through improved IPM systems, that includes control, cultural practices, monitoring, biological controls and responsible use and is widely adopted in many communities. A critical part of this project is the development and deployment of ecologically effective biocontrols and biopesticides - against the pod borer in particular - to boost IPM. This project capitalizes on technologies developed and tested in earlier research, and are ready for scaling up, and strategic partnerships established to implement the project activities. Success will depend on critical inputs, including research investments, prerequisite research capacity and infrastructure, priorities and targets by the Legume Lab, and climatic and agro-ecological factors, national and regional priorities/policies.

**Collaborators:** Manuele Tamò, International Institute of Tropical Agriculture (IITA), Benin. Fousseini Traoré, Institut de l'Environnement et du Recherches Agricoles (INERA), Burkina Faso. Amadou Laouali, L'Institut National de la Recherche Agronomique du Niger (INRAN), Niger. Ibrahim Baoua, Université de Maradi, Niger. James Ojo, Kwara State University (KWASU), Nigeria. David Mota-Sanchez, Michigan State University, USA. Julia Bello-Bravo, Michigan State University, USA.

**Achievements:** One of the key highlights with regard to biocontrol agents was the mass release of 45,000 individuals of *Phanerotoma syleptae* and 8,000 individuals of *Liragathis javana* which took place May 31 – June 5 on wild vegetation at the margins of the Falgore Forest Reserve south of Kano, Nigeria. The releases were carried out in close collaboration with officers of the Nigeria Agricultural Quarantine Services and colleague scientists from the University of Kano and IITA. This is the first critical release close to the most important cowpea production area in northern Nigeria.

A major activity in Niger was the validation of the Farmer Interface App FIA-niebe with some 70 participants, including 32 farmers, 5 national researchers and extension agents, and 22 grad students from the University in Maradi. As a result of the validation the number of plants to be scouted are reduced from 6 to 4 per scouting station with one plant each at the front, back, and on both sides. The total will be 40 plants per plot to be scouted instead of 60. Inspection of the plants should be carried out clockwise for each scouting



station. With regard to the infestation levels, farmers are asking if we can include in the app a color coding. For example, for the pictures of healthy pods use green color and red color for attacked pods. This color coding can be applied for other pest damages. Future versions should include scouting for multiple pests on different crops. Challenges included accessing the scouting data on a computer for further analysis and unstable internet connectivity in some rural areas.

Also in Niger, some 2005 farmers (1184 man and 821 women) were trained through an awareness campaign about risks of using chemical pesticides and benefits of biopesticides in three regions (Maradi, Zinder and Tahoua). In FY2023, three new neem tea bag production units produced some 6,539 additional neem tea bags, bringing the total over the project duration to 15,989. SAWBO Neem Tea Bag animation was created with the collaboration of the Innovation team in Niger, Burkina Faso, and Benin. The animation explains how to harvest, process, package and use neem tea bags as a natural insecticide to address insect pests and increase yield for smallholder farmers. <https://sawbo-animations.org/1624>.

In Burkina Faso, studies investigating the biodiversity of cowpea thrips revealed a single specimen of a putative exotic thrips species (tentatively determined as originating from Central America), never recorded before on the African continent. Separately, two scientific articles featuring the work achieved during the project were published in *Current Opinion in Insect Science*, a reputable high impact outlet.

**Objective 1** (Assess the ecological interactions regulating populations of the pod borer)- In Nigeria, the team monitoring of establishment of the released biocontrol agents during off season on alternative wild host plants continued to find few specimens of the biocontrol agent *Liragathis (Therophilus) javana* on herbaceous legume (*Sesbania sp.*) during the sampling activities, which supports observations from other countries with previous releases. The fact that the team were not able to recover the biocontrol agents in greater numbers is mainly due to the low population levels of the host, the pod borer *M. vitrata*. The team did recover the biocontrol agents in Nigeria, and this is very encouraging in view of the releases just carried out early in the year around the Falgore Forest Reserve south of Kano.

**Objective 2** (Assess the pest status of emerging, climate-driven insect pests) - Investigation of in-field host finding capacity of the biocontrol agent *Therophilus javanus*. The aim here is to understand the mechanisms underlying the host location, starting by investigating the visual location of the host plant (visual cues) in choice and no-choice test arenas under field conditions. Thereby, a differential of rustical and improved cowpea varieties will be tested together with West African wild *Vigna* species, and the most commonly occurring wild herbaceous legumes. Once the plant is selected by visual cues, the parasitoid is expected to start locating suitable host larvae by long and short range plant volatile cues, which the plant might emit with or without the attack of the pod borer.

The methodology used to achieve this objective has been modified in view of the difficulties encountered with direct observations in the field, but also because of the new facilities at the chemical ecology lab at IITA-Benin which has just been completed. These studies have been carried out in the field in Nigeria, because of the proximity to the IITA-Benin labs which facilitates the exchange of trapped volatiles and also capacity building of the KWASU staff in chemical ecology. The focus of the work is to isolate cowpea plant volatiles from undamaged and damaged flowering structures, in order to find olfactory cues guiding the host finding behavior of the parasitoid *L. javana*. The IITA-Benin based post-doc in chemical ecology visited KWASU Ilorin end of September 2022 to train host country collaborators and a student on volatiles collection. A publication is being prepared for submission. Additionally, current efforts are on-going at IITA-Benin to collect volatiles from some of the major alternative dry season host plant for the pod borer, and the next step will be the comparison with those from cowpea to detect analogues.

**Objective 3** (Screen fungal biopesticides against emerging and invasive pests)- The new approach developed at IITA-Benin using the insect *Galleria mellonella*, a standard insect whose larvae are used to isolate entomopathogenic fungi and nematodes from conducive soils, has been applied to soils collected from different localities in Burkina Faso and Nigeria. So far, some 9 isolates of entomopathogenic fungi have been collected, morphologically characterized, and tentatively identified as *Beauveria bassiana*. DNA has been extracted from the isolates and sent to MSU for molecular characterization. In Niger, on-station experiments at the INRAN station in Maradi assessed the performance of various biopesticides. Generally, pod borer populations were very low with maximum numbers of 5.8 larvae per plot. Hence, the effect of the different treatments was not significant for this pest. It remains to be investigated, mid- to long term, whether these population reductions can be ascribed to releases of biocontrol agents as earlier observed in Benin and Burkina Faso. The population of the pod sucking bugs *Clavigralla tomentosicollis* was higher on the control (unsprayed) plots throughout the season, with a peak of over 580 individuals per plot towards the end of the season at pod maturity. Among the biopesticides, the neem seed extract and the entomopathogenic fungus *Beauveria bassiana* gave comparable results with the chemical pesticide, which confirms observations made during earlier studies.

**Objective 4** (Validate various IPM baskets) – The team in Niger studies 12 villages of the departments of Madarounfa Aguié and Guidan Roundji in the Maradi region. In summary, the greatest incidence of insects was observed with control (untreated) plots (23.67%) followed by *B. bassiana* (23.44%), while the incidence was observed with the treatment based on neem seed extract (16.55%) and synthetic pesticide (16.09%). The results confirm on-station observations that neem seeds gave a satisfactory control of pests comparable to the chemical pesticide. Grain yields were higher with the synthetic pesticide (2025 kg/ha), followed by neem seed extract (1507), the entomopathogenic fungus *B. bassiana* (1294), while the unsprayed control only gave 716 kg/ha.

Demonstration plots comparing neem seed extract with unsprayed control were also established in three (3) villages of Aguié notamant at Dan Tchiro, Naki Karfi, and Dan Saga. The neem seed extract treatment recorded the highest yield of 1044.83 kg/ha compared to the control treatment (823.66 kg/ha) a difference of 221.17 kg/ha.

A further demonstration trial was conducted in the region of Zinder in three (3) villages of the department of Mirriah. The three villages were Falki babba, Hotoro, and Bilmari located at 4 km, 6 km and 3 km from Mirriah, respectively. Cowpea yield varied between treatments in all villages ( $F=36.27$ ;  $P=0.001$ ;  $F=28.59$ ;  $P=0.001$  and  $F=47.98$ ;  $P<0.001$ ) respectively for Falki, Hotoro and Bilmari. Synthetic pesticides gave the highest yields, with an average yield of over 1000kg/ha. Yields from plots treated with biopesticides were 2.15 to 4.72 times higher compared to control plots regardless of the village. It needs to be noted that in this region no releases of biocontrol agents and hence the pest pressure is much higher than the around Maradi.

**Objective 5** – (Scale out the biocontrol agents against the pod borer). One of the key highlights with regard to biocontrol agents was the mass release of 45,000 individuals of *Phanerotoma syleptae* and 8,000 individuals of *Liragathis javana* which took place May 31 – June 5, 2023 on wild vegetation at the margins of the Falgore Forest Reserve south of Kano. The releases were carried out in close collaboration with officers of the Nigeria Agricultural Quarantine Services and colleague scientists from the University of Kano and IITA. The release was done in conjunction with sensitization campaigns targeting neighboring farming communities to explain basic principles of biological control and benefits of using biopesticides. This is the first critical release close to the most important cowpea production area in northern Nigeria.

**Objective 6** (Scale out the community-based production of neem tea-bags in Niger)– The neem based biopesticide production units in Niger continued to be fully operational. A total of six production units, with production of 6,539 additional neem tea bags, bringing the total over the project duration to 15,989 (923 bags during 2020, 3002 bags during 2021, 5525 bags during 2022, and 6539 bags for 2023).

**Objective 7** Training (see Capacity Development below)

**Objective 8** (Focus Group research and education materials.) SAWBO created the Neem Tea Bag animation (<https://sawbo-animations.org/1624>). This animation explains how to harvest, process, package and use neem tea bags as a natural insecticide to address insect pests and increase yield for smallholder farmers.

The animation was created through the collaboration of the innovation teams in Niger, Burkina Faso, and Benin. The animation was first released in English and has been translated (see USAID/Niger buy-in) to French and four local languages: Fulani, Hausa, Kanuri, and Zarma, with other anticipated in Niger and Burkina.

**Objective 9** (Develop and validate ICT decision making tools) - A major activity in Niger was the validation of the Farmer Interface App FIA-niebe with some 70 participants, including 32 farmers, 5 researchers and extension agents, and 22 grad students from the University in Maradi. The main finding from the validation of the FIA was the reduced number of plants to be scouted from 6 to 4 per scouting station (one plant each at the front, back, and on both sides). The total will be 40 plants per plot to be scouted instead of 60 plants. Inspection of the plants should be carried out clockwise for each scouting station. Regarding the infestation levels, farmers are asking if we can include in the app a color coding. For example, pictures of healthy pods in green and attacked pods in red. The color coding can be applied for other pest damages in the FIA-niebe. Future versions should include scouting on different crops and address technical issues around unstable internet connectivity in some rural areas for voice commands and stability of GPS captures.

The project also received a Cross-Cutting Theme supplemental award to expand the use of FIA-niebe in Niger. Recoding of the app allows scouting for more than one pest and voice commands (currently only in French but in development for Hausa). For the moment, using voice commands is only possible through internet connectivity, but a 'light' version using resident voice commands is being discussed with the coders. While this might be easily achievable for French voice libraries, it will be quite difficult to implement for local languages. However, given the increased access of internet in rural areas, the internet-able version will allow more functionalities including data upload and future communication such as cloud-based climate advisors.

### **Capacity Development:**

In Niger, group training included validation of the Farmer Interface App, FIA-niebe, with 70 participants, including 32 farmers, 5 national researchers and extension agents, and 22 grad students from the University in Maradi. In Niger, 2005 farmers (1184 men and 821 women) were trained through an awareness campaign about risks of using chemical pesticides and benefits of biopesticides in three regions (Maradi, Zinder and Tahoua).

French, Hausa, Kanuri, Zarma, and Fulani translations of the SAWBO video, describing in detail the production and delivery of neem tea bags, and promoted by the USAID Niger Mission Buy-in saw over 20,000 views on YouTube alone since its release in May 2023. The views per language are French 3,400 views, Fulani 46 views, Hausa 7,600 views, Kanuri 5,400 views, and Zarma 3,600 views

Individual and Degree training

Burkina Faso: 2 Phd (on-going), all female

Niger: 1 Phd (on-going), 2 MSc (one completed), all female

Nigeria: we were happy to host our co-PI Dr Ojo for a 12 days for training at our facilities in IITA-Benin, Cotonou. Main focus of the training on new methodologies of rearing the pod borer *Maruca vitrata* and its parasitoids *Liragathis javana* and *Phanerotoma syleptae*, together with observation on host finding behavior and installation of pheromone traps in the field. He also got acquainted with new equipment in our chemical ecology and molecular analytics labs. On his way back to Ilorin, he carried some 10,000 parasitoids, covered by all regulatory paperwork, for experimental releases and colony initiation. This training was followed by on-

site training provided by our consultant in chemical ecology to KWASU, to give hands-on demonstrations of volatile collecting methodologies and use of pheromone traps.

**Lessons Learned:** Existing rearing conditions in host country entomology labs cannot warrant year-long rearing of the pod borer *M. vitrata* and its parasitoids, so we can only keep the colonies during the wet season. In order for host country labs to keep colonies during the dry season, major upgrading and refurbishing of the labs would be needed which is beyond the reach of this project.

Converting the FIA-niebe voice commands to Hausa has been slower than anticipated due to the limited availability of voice banks and voice recognition in Hausa language. The technical team leveraged additional funding from other projects to continue this work beyond FY2023 and is confident in completing the work.

#### **Presentations and Publications:**

Bello-Bravo, J., Medendorp, J., Lutomia, A., Reeves, N., Sal, V., Tamo, M., & Pittendrigh, B. (September 2022). “Dramatically increased accessibility and decreased cost-per-person impacts are needed for scaling IPM in Africa” (pp.100971). *Current Opinion in Insect Science*, 54(2022), Amsterdam available at <https://doi.org/10.1016/j.cois.2022.100971> (Peer Reviewed).

Tamo, M., Glitho, I., Tapa-Yotto, G., & Muniappan, R., (August 2022). “How does IPM 3.0 look like (and why do we need it in Africa)?” (pp.100961) *Current Opinion in Insect Science*, 53(2022), Amsterdam available at <https://doi.org/10.1016/j.cois.2022.100961> (Peer Reviewed).

#### **AOI 1.3: Optimized Shrub System (OSS): An Innovation for Improving Cowpea Yields and Strengthening Smallholder Resilience in Senegal**

**Locations:** Senegal (Thies and Kaolack)

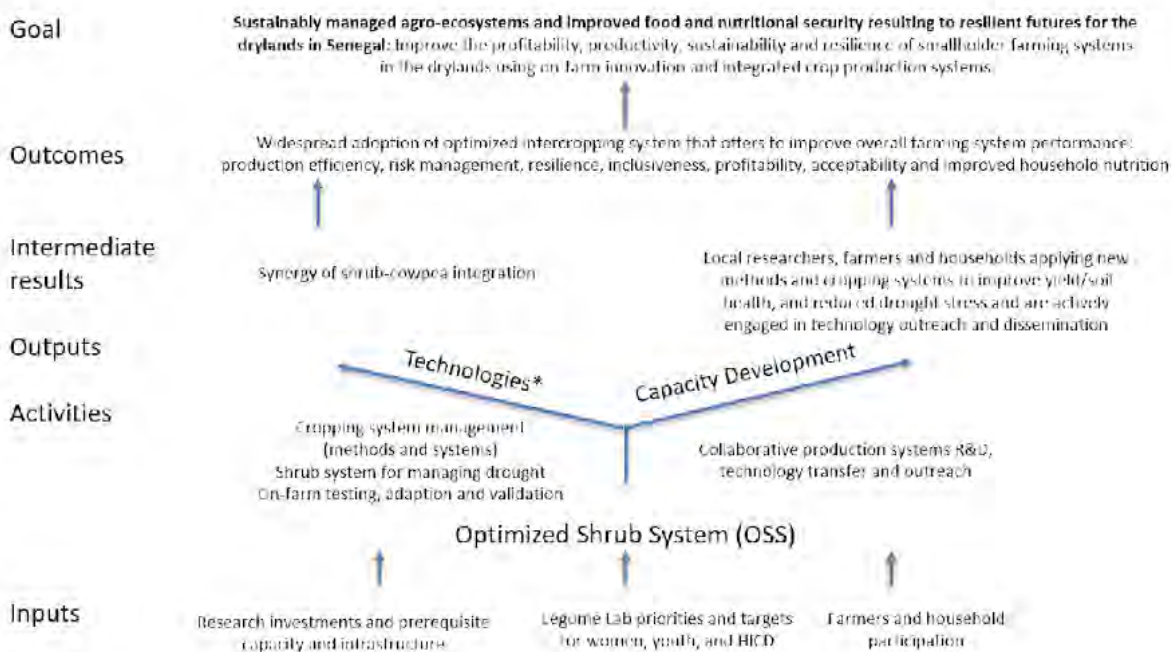
**Description:** West Africa suffers from recurring drought and degraded soils, which limits productivity of cowpea, an important source of protein and income for rural households in the Sahel. This project will pilot test and adapt the Optimized Shrub-intercropping System (OSS) to improve cowpea production.

OSS utilizes 2 indigenous shrubs (*Guiera senegalensis* and *Piliostigma reticulatum*) at densities of 1200-1500 shrubs/ha that includes annual incorporation of aboveground biomass – a system our research (31+ refereed journal articles) has shown dramatically increases crop yields (millet and peanut), remediates degraded soils, and profoundly, we have shown that shrubs use hydraulic redistribution to “bioirrigate” adjacent crops – a powerful mechanism to combat in-season drought.

The productivity of this cowpea system will be evaluated under OSS management in comparison to the traditional management system (low or zero shrub density/burning of shrub residue) under farmer management.

The project will also test an intriguing option for double cropping cowpea - determining if a second cowpea crop can produce harvestable yields at the beginning of the dry season by utilizing “shrub bioirrigated” water. A screening of cowpea cultivars that range in duration and phenotypic characteristics to identify superior lines for OSS will be done.

## Theory of Change and Impact Pathways(s):



This TOC begins with a goal of sustainable management of natural resources and agro ecosystem services and improved food and nutritional security resulting to resilient futures for the drylands in Senegal. The project **"Optimized Shrub System (OSS): An Innovation for Improving Cowpea Yields and Strengthening Smallholder Resilience in Senegal"** contributes to this goal by encouraging the widespread adoption of optimized intercropping system that offers to improve overall farming system performance: production efficiency, environmental risk management, resilience, inclusiveness (gender sensitivity), profitability, acceptability and improved nutrition. This can be achieved through synergy of shrub-cowpea integration, and local researchers (current and future), farmers and households applying new methods and cropping systems to improve yield/soil health, and reduced drought stress and are actively engaged in technology outreach and dissemination. A critical part of this project is the engagement of local communities, and the choice of cowpea varieties for OSS. This project capitalizes on local knowledge base, and previously discovered methods and processes to integrate shrubs into the cropping system. Success will depend on critical inputs, including research investments, prerequisite research capacity and infrastructure, priorities and targets by the Legume Lab, and farmers and household participation.

**Collaborators:** Richard Dick, Ohio State University, USA. Moussa Diangar, ISRA, Senegal. Amanda Davey, Ohio State University, USA.

**Achievements:** Under the objective to screen cowpea cultivars for superior performance under OSS Improved varieties namely Sam, Thieye, Lisard, Leona, Kelle, Yacine, Mouride, and Bambey. Varieties tested under Optimised Management System (OSS) and Traditional Management System (TMS) in farmers' field in Thies at Keur Matar Aram and in Niore at Keur Ndari. Under OSS, cowpea varieties were intercropped with shrubs *Guiera senegalensis* and *Piliostigma reticulatum* respectively in Thies and Niore. Under TMS, cowpea was planted without any input. The experiment was led out in factorial design with 2 factors the variety and the plot management system and 3 replications. Results of the analysis of variance showed a highly significant effect of the interaction of varieties and management system on seed yield ( $P < 0.001$ ); the management system had a strong influence on the yield with a variance seven (7) times more influential than that of the genotype. The results showed that the best yields were obtained at plot instances where cowpea was intercropped with *Piliostigma reticulatum* with yields of 2646.66 Kg/ha versus 70.89 kg/ha and 365.08 kg/ha versus 1612.18 Kg/ha respectively for the plots in Niore with *P. reticulatum* (Pil +) versus (Pil -) and the plots in Thiès with *G. senegalensis* (Gui +) versus (Gui -). The best yields were obtained with the Yacine and Kelle varieties with respectively 3411.7 Kg/ha and 3332.3 Kg/ha at plot level (Pil +). The lowest yields were recorded for the Lizard and Thieye varieties with respectively 10.1 Kg/ha and 21.3 Kg/ha at plot level (Pil +). Seeds have been stocked in small bags for the nutrition analysis experiment

**Capacity Development:** Training of a technician on intercropping cowpea with shrubs. One Master student trained on OSS and TMS (ENSA, Universite de Thies) and one Master student trained on effects of *Pilistigma reticulatum* on cowpea grain yield name (Universite Assane Seck).

A SAWBO animation was also produced to help train farmers on the benefit of keeping native shrubs in the field and how to manage these shrubs. The animation, Using Native Shrubs to Increase Soil Health and Crop Yield can be viewed online at <https://sawbo-animations.org/1623>. The animation is available in English and also in Senegalese spoken languages Wolof, French, and Arabic. The animation is being used as an extension educational aid.

#### **Lessons Learned:**

- Trials in the farmers' field need attention equal to the trials in the research stations. This involves more resources to allow the team in charge of the planting to be in the nearby location to plant once the first significant rainfall drops.
- More students need to be involved as they bring major contributions while studying for their thesis.
- Visits should be organized at least twice outside the trial period to engage more with farmers.

#### **Presentations and Publications:**

Dick, R., Diedhiou, I., & Davey, A. (February 2023). Optimized Shrub System (OSS) for Food Production, Drought Resistance and Ecosystem Restoration in the Sahel. Presentation at Legume Systems Research Innovation Lab Global Convening, Livingstone, Zambia.

Diangar, M., Dick, R., Davey, A., & Diedhiou, I. (February 2023). Optimized Shrub System (OSS): An innovation for improving cowpea yields and strengthening smallholder resilience in Senegal. Presentation at Legume Systems Research Innovation Lab Global Convening, Livingstone, Zambia

## **B. Area of Inquiry 2**

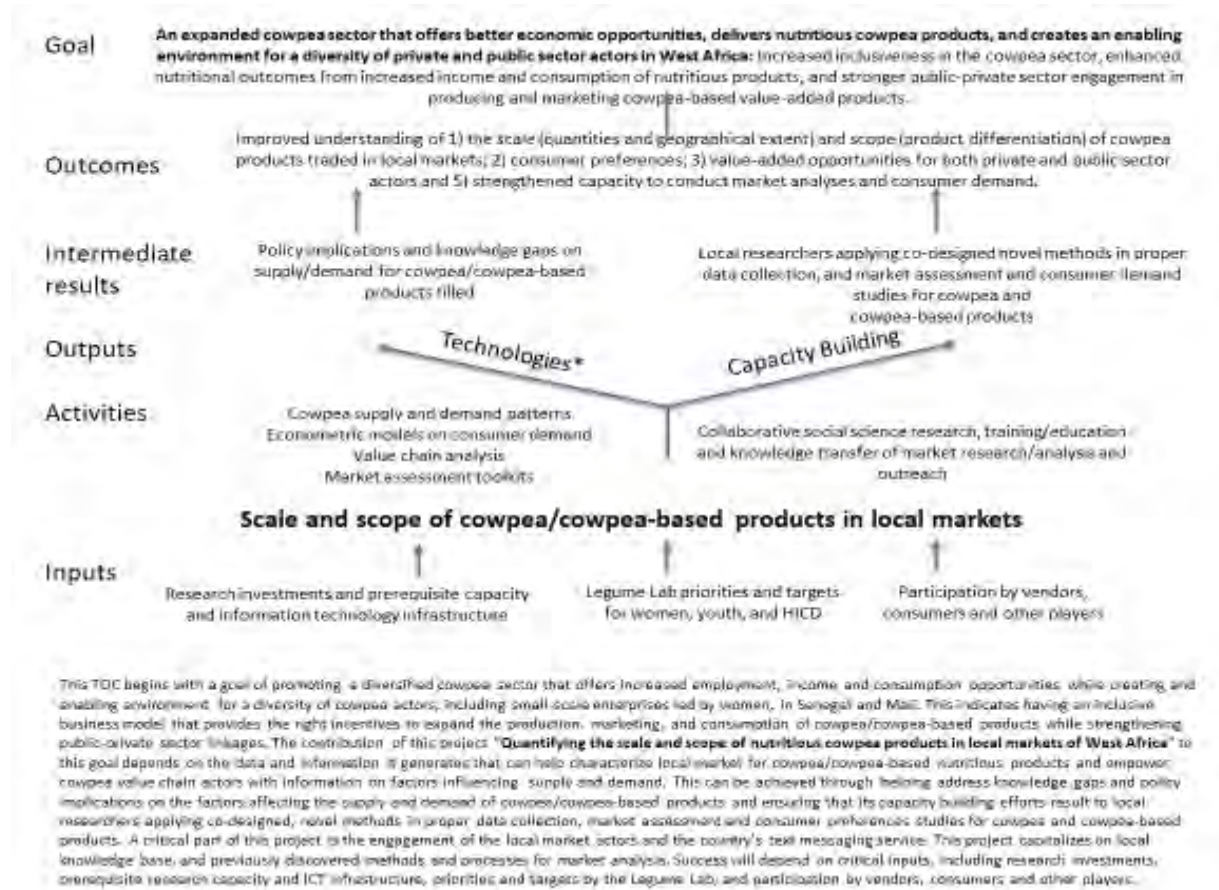
### **AOI 2.1: Quantifying the Scale and Scope of Nutritious Cowpea Products in Local Markets of West Africa**

**Locations:** Senegal and Mali (Districts to be determined)

**Description:** West Africa is the global locus of cowpea production. Across the region, cowpea products provide critical nutrients and cash income to smallholder farmers. Yet, little is known in quantitative terms about the scale and scope of cowpea products in local markets. Market-based incentives for products other than grain, including leaves, processed, and nutritious products have received less attention. The research in Mali and Senegal seeks to close this information gap. Researchers will build a quantitative inventory of cowpea products supplied and demanded in local market hubs, record product, vendor, and market characteristics, and collect shopper data in lean and abundant seasons to test the effectiveness of market-based incentives on consumer behavior. Through several conduits, researchers will strengthen the capacity of local partners to conduct market analyses, assess consumer demand, and implement policy research using innovative methods and tools.



## Theory of Change and Impact Pathways(s):



**Collaborators:** Veronique Theriault, Michigan State University, USA. Melinda Smale, Michigan State University, USA. Aliou Diagne, University of Thies, Senegal. Mamadou Sissoko, Universite des sciences sociales et de gestion de Bamako, Mali.

**Achievements:** The team investment in research and capacity strengthening resulted in a series of outputs in the form of evidence-based research findings and skilled human resources. The project's research outputs, and capacity development led to two outcomes: 1) dissemination of and access to new knowledge; and 2) improved human and institutional capacity. Specifically, 1. Generated insights from the analysis of consumer demand for cowpea products, constraints, and opportunities, with a particular focus on emerging, value-added products. About 540 urban and rural households across 3 regions were interviewed about their food consumption patterns, including cowpea across two seasons. About 600 urban and rural households across all 14 regions were interviewed in Senegal. 2. Supervise 6 graduate students and offered short-term training to over 50 researchers and students. 3. Generated several research outputs. Most of the research papers are currently (or soon) to be under review for publication in peer-reviewed journals. 4. Prepared outreach materials that was shared with key stakeholders at workshops and conferences. 5. Engaged with private and public actors in the cowpea value chain through informal meetings and closing policy workshops. Two of our team members received awards: Sissoko, M. 2023. Early Career Grain Legume Scientist Award. FtF LRS-IL. Carlson, H. 2023. Glenn & Sandy Johnson Dissertation Enhancement Fellowship.

**Capacity Development:** The team organized two short-term training sessions on how to use agronomic data to make recommendations. Over 50 people participated in the sessions. Long-term capacity building was a

key component of the project. Nine students in degree granting programs received support from the project. Four have completed their degree, 4 are female, 4 are from Mali and 4 are from Senegal. This year, five students from local universities and one student from MSU participated in the project activities under the supervision of the co-PIS.

**Lessons Learned:** The utilization of research outputs can be seen through the recommendations made by key cowpea stakeholders during the closing workshops in both countries. They provided networking opportunities for participants to share their ideas and recommendations on the opportunities and challenges to better integrate cowpea and cowpea products into local and regional market channels in Mali and Senegal and into the school canteen menus in Senegal.

### **Presentations and Publications:**

Diagne, A. (May 2023). aille potentielle du marché du niébé au Sénégal lorsque les vendeurs ne sont pas soumis à des contraintes. Presentation at Dissemination Workshop, Thies, Senegal

Diallo, D. (May 2023). Analyse spatio-temporelle des marchés dans la commercialisation du niébé au Sénégal.. Presentation at Dissemination Workshop, Thies, Senegal

Ndiaye, S., Diagne, A., & Theriault, V.. Analysis of Demand for Cowpea in Senegal- An Application of the Engel Curve. (in French).

Sissoko, M. (February 2023). Analysis of the Structure, Conduct, and Performance of the Cowpea Market in Mali.. Presentation at FtF Legume Systems Innovation Lab Annual Convening, Zambia

Sissoko, M. & Theriault, V.. Analysis of the Structure, Conduct, and Performance of the Cowpea Market in Mali. (in French)

Sissoko, M. & Theriault, V. (May 2023). Atelier de partage des résultats. Presentation at Dissemination workshop. Mali, Bamako, Mali

Sissoko, M.. Atelier de partage des résultats de recherche au Mali.

Diagne, A.. Atelier de partage des résultats de recherche au Sénégal

Smale, M., Assima, A., & Theriault, V.. Cowpea grain sales by women and men traders in local markets of Senegal.. Journal of Agribusiness in Developing and Emerging Economies (Peer Reviewed)

Fatoumata Sarr, A. (July 26, 2023). Cowpea Grain Supply in Local Markets of Senegal. Universite de Thies.

Diagne, A. & Theriault, V.. (2023) Cowpea market size and scope of product varieties in Senegal: Estimation of actual and potential volumes of sales, clients served and revenues when sellers are unconstrained.

Carlson, H.. Determinants of Food and Cowpea Processing Among Senegalese Traders: A Triple-Hurdle Analysis. Research Paper.

Diagne, A. (February 2023). Estimation of potential increases of market supplies of cowpea-based products through improved product availability, storage, information, and consumer demand: The case of Senegal.. Presentation at FtF Legume Systems Innovation Lab Annual Convening, Zambia

Diagne, A. (January 2023). Estimation of potential population cowpea market sizes when sellers are unconstrained by product variety information, availability, storability, and consumer demand: The case of Senegal. Presentation at AFRE Departmental Seminar., Michigan, USA

Diagne, A. and Theriault, V. 2023. Estimation of potential population cowpea market sizes when sellers are unconstrained by product variety information, availability, storability, and consumer demand: The case of Senegal. Research Paper

Carlson, H. (February 2023). Determinants of participation in processed cowpea markets: Evidence from Senegal. Presentation at FtF Legume Systems Innovation Lab Annual Convening, Zambia., Zambia

Fatoumata Sarr, A. (May 2023). Étude de l'offre en grains de niébé et de ses déterminants dans les marchés locaux au Sénégal.. Presentation at Dissemination Workshop, Thies, Senegal

Fatoumata Sarr, A. (December 16, 2022). Etude de l'offre en grains de niébé et de ses déterminants dans les marchés locaux du Sénégal. Université de Thies

Diagne, A.. Politique d'intégration des produits à base de niébé dans les menus des cantines scolaires du Sénégal

Diagne, A., and Ndiaye, S. 2023. Politique d'intégration des produits à base de niébé dans les menus des cantines scolaires du Sénégal. Field Report. January.

Theriault, V. (February 2023). Quantifying the Scale and Scope of Nutritious Cowpea Products in Local Markets of West Africa.. Presentation at FtF Legume Systems Innovation Lab Annual Convening, Zambia, Zambia

Ndiaye, S. (May 2023). Résultats de la mission de concertation sur la politique d'intégration de produits à base de niébé dans les menus des cantines scolaires du Senegal.. Presentation at Dissemination Workshop, Thies, Senegal

Theriault, V., Assima, A., Sissoko, M., and Smale, M. 2023. The Importance of Cowpeas in Mali's Household Dietary Habits. Research Paper

Carlson, H. (January 2023). What factors affect the decision to become a food processor and to specialize in cowpea processing? Evidence from Senegal. Presentation at AFRE Department, Brown Bag Seminar., Michigan, USA

Carlson, H. (July 2023). What factors affect the decision to become a food processor and to specialize in cowpea processing? Evidence from Senegal.. Presentation at Agricultural and Applied Economics Association, Annual Meeting., Washington D.C.

## **AOI 2.2: Promoting Trade Integration in Regional Legume Markets with Mobile Technology**

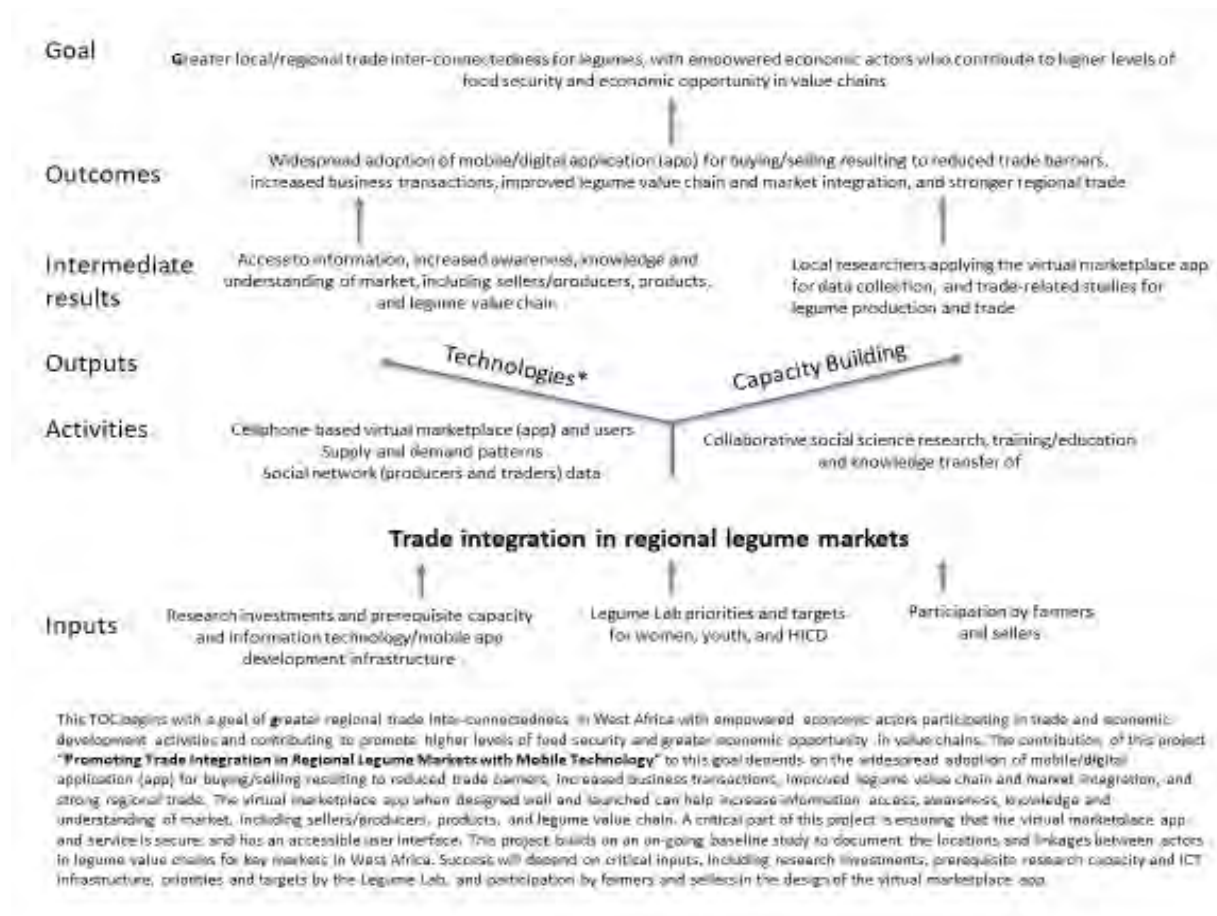
**Locations:** Nigeria (Kano and Ilorin)

**Description:** This project examines how mobile-phone technology, launched as the KasuwaGo app, can bridge the barriers between farmers, wholesalers, and retailers in the legume value chains. The goal is to improve the functioning of existing markets, and to promote market integration between the major producing areas and markets in West Africa.

The mobile phone-based service allows producers and traders to communicate and agree on the quantities they wish to sell, and the prices they will accept. It also allows users to rate the quality of services and products received, using multiple local and foreign language options.

The project’s research component expands understanding the adoption of mobile phone-based technology in value chains, the drivers of effective communication between farmers and sellers, as well as the effects of communications improvements on market outcomes.

**Theory of Change and Impact Pathways(s):**



**Collaborators:** Michael Olabisi, Michigan State University (MSU), USA. Eric Crawford, MSU, USA. Toyin Ajibade, University of Ilorin, Nigeria. Hakeem Ajeigbe, Bayero University in Kano and ICRISAT, Nigeria. Mywish Maredia, MSU, USA.

**Achievements:** The research team launched the KasuwaGo app in June 2021, to provide actors in the legume value chain a virtual marketplace -- breaking market barriers to information access for anyone with a smartphone. The team trained and deployed more than 200 youth to reach out to markets, as technical help agents to support traders and farmers who were interested in the app. The teams of mostly youth reached more than 200 markets. The number of registered users for the e-marketplace reached 13,000 users. In FY2023, the team handed the app off to Novus Agro, a Nigeria-based company to manage the app for the long term.

The research team conducted an impact evaluation survey in Nigeria through a sample of registered users to understand how using the app has added value to them.

Two doctoral students from Nigeria completed their visit to Michigan State University as part of the HICD efforts. The students completed their classwork and research schedule at MSU and returned to Nigeria in Dec 2022. The students' supervisors visited MSU in October. This helped to involve the student's institutions, and to promote increased research engagement between the students' universities and MSU. The research team attended the global convening in Zambia, where the co-PIs, as well as the students presented our research. Submitted at least one paper to a journal. We submitted one of the working papers from our research efforts to an academic journal. Presentation for student at Unilorin completed in April or May. We had close out meetings with stakeholders in Nigeria We licensed the app to Novus Agro, completing the system transition as part of our resilience plan for the project. We submitted manuscripts based on the work to journals for review. One of these was accepted for presentation at an academic conference scheduled for January 2024.

**Capacity Development:** Training activities for 94 enumerators and youth (40 female) in Kano and Ilorin (Nigeria) before the outreach program. In Niger, training programs for 39 enumerators and youth (12 female). Host country partners selected two candidates to visit MSU for the Fall 2022 semester, as part of the project Human and Institutional Capacity Development goals. The two scholar visitors are at MSU, attending classes, and engaged with other research activities including seminars.

**Lessons Learned:** Tech delays and module integration issues disrupted project plans.

#### **Presentations and Publications:**

Maredia, M., Olabisi, M., & Ajibade, T. (February 2023). Adoption of Mobile Technologies in Nigeria: Is there a Gender Gap?. Presentation at Global Convening, Livingstone, Zambia

Sambo, A., Ajeigbe, H., Maredia, M., & Olabisi, M. (February 2023). Gender Differences in Trade Profit Margins: Evidence from Nigeria. Presentation at Global Convening, Livingstone, Zambia

Olabisi, M., Maredia, M., Ajibade, T., & Ajeigbe, H. (February 2023). In-Group Competition for Research Incentives: A Randomized Control Approach. Presentation at Global Convening, Livingstone, Zambia

Olabisi, M., Maredia, M., Ajibade, T., & Ajeigbe, H. (October 2022). In-Group Competition Incentives for Fieldworkers. Presentation at Development Lunch Seminar Series, East Lansing MI

Ajeigbe, H., Sambo, A., Maredia, M., Ajibade, T., & Olabisi, M. (February 2023). Regional Differences in Trade Profit Margins: Evidence from Nigeria. Presentation at Global Convening, Livingstone, Zambia

Olubunmi, A., Ajibade, T., & Maredia, M. (February 2023). Use of Mobile Phone Technologies in Legume Value Chains: Evidence from Nigeria. Presentation at Global Convening, Livingstone, Zambia

Ajibade, T. (February 2023). Youth-Led Market-Based ICT Support Services Provision as a Drivers for Virtual Ag Trade Platforms Usage by Women. Presentation at Global Convening, Livingstone, Zambia

#### **MSI 2.2-1: Measuring the Impact of Digital Technologies on Informal Traders Productivity**

**Locations:** Benin (Kano and Ilorin)

**Description:** This research aimed to understand the adoption and usage of digital technologies among legumes traders in Benin, and the role that these technologies play in their economic activities. To achieve these goals, we collected and analyzed data through a statistical survey at a rural market (Bohicon market) and at a semi-urban market (Ouando market) in Benin. The former is a small town of 150,000 people located at 124 kilometers east to the big city of Cotonou, while the latter is a relatively larger town of 246,000 people located at 9 kilometers away from the big city of Porto Novo. These two markets are among the major ones where one can readily buy and/or sell grains that are produced by most local farmers in Benin including beans, maize, peanuts, cowpeas, melon seeds, etc.

The project's initial intent was to narrow our investigation to the use of the KasuwaGo App, a relatively new technology developed by the Legume Systems Innovation Lab, that is increasingly used among traders and farmers in the neighboring countries Nigeria and Niger, but remains unknown among their counterparts in Benin. However, due to technical issues (that are discussed below), we couldn't follow up on this targeted objective, but expanded our investigation in understanding how the broad use of digital applications in mobile phones affects legume trader's activities in those locations. Our sampling strategy was based on census information and our survey collected data from 451 buyers and sellers distributed across these markets. Information collected through our survey included data on business characteristics and outcomes (e.g., sales, number of transactions, business ownership, business size); access and usage of digital technologies (e.g., social media, mobile money, internet browsing, Youtube, KasuwaGo app, weather); personal characteristics (e.g., age, schooling, experience, type of training/education, wealth, etc.); risk aversion (e.g., willingness to trade with new/different partners, willingness-to-pay to insure some type of risk); access to credit (e.g., type of credit, demand for credits, sources of funding); and bad business experiences (e.g., cases of scams, deception, previous enterprise failure).

We found that digital technologies are desired and used by the majority of traders (51% of respondents are using mobile apps beyond simple calls/texts), both at the extensive margins and at the intensive margins. Constraints to adoption and/or usage of these digital technologies include lack of digital skills, unawareness of benefits, high costs of mobile services and broadband network, and fear of fraud, and bridge of privacy. Moreover, those that use DTs tend to have higher numbers of employees, and higher number of transactions than their counterparts that do not use DTs. Our results also reveal three salient facts: there is a high degree of women's participation in the legumes value chain (81% of our traders are women), high level of financial inclusion (94.7% of respondent use mobile payments at least once a month), high level of skills upgrading (52% of our respondents have never received formal education, yet have digital literacy and can learn new skills through apps).

**Collaborators:** Pierre Nguimkeu, Georgia State University, USA. Michael Olabisi, Michigan State University (MSU), USA. Brice Gbaguidi, IITA, Benin.

**Achievements:** An initial pilot survey was performed in the regions of Bohicon, Glazoué, Azovè, Ouando and Kétou markets, in January 2023, and the survey was later administered between May and July 2023. We also had meetings with the managers of the targeted market, government officials as well as leaders of the associations of traders. The purpose of these meetings was to inform them about the objectives of our study and the associated details. Before the survey, a training session was organized at IITA-Benin to train the enumerators on SurveyCTO, an app used for data collection on the field. Several field visits were conducted to meet the market actors in order to put together a list of potential survey participants.

A random sample of 100-200 participants per market was drawn from this list using a stratified sampling, and appointments were scheduled to meet with the participants on days outside of the main market days. As an incentive to participate and complete the survey, airtimes vouchers of 500 CFA were promised and given to survey participants upon completion of the questionnaire. Participants who withdrew from the survey at the last minute were systematically replaced by those from the potential pool. In the markets of Bohicon, Glazoué and Kétou, it was relatively easy for the enumerators to reach their set number of respondents. In



Azovè and Ouando, however, it was much difficult to get participants responses, due to suspicions of taxes and complaints against the government, which had moved them to rebuild the market. Finally, a total of 451 respondents were successfully interviewed in these markets after several attempts (an average of 3 attempts per respondents), and few replacements using either other participants from the potential list or a “snowball” approach (i.e., having one respondent point us to another one).

Data Analysis: The raw data were stored in a server during the collection and the principal investigators were able to retrieve them from the SurveyCTO platform and convert them in a readable format (such as .csv). We then cleaned the data, recode qualitative variables and performed data imputations and other data management tasks. The data were then analyzed to answer some of our main research questions. The questionnaire consisted of more than a hundred variables covering business characteristics and outcomes (e.g., sales, transactions, business ownership, business size); access and usage of digital technologies (e.g., social media, mobile money, internet browsing, Youtube, KasuwaGo app, weather); personal characteristics (e.g., age, schooling, experience, type of training/education, wealth, etc.); risk aversion (e.g., willingness to trade with new/different partners, willingness-to-pay to insure to some type of risk); access to credit (e.g., type of credit, demand for credits, sources of funding); and bad business experiences (e.g., cases of scams, deception, previous enterprise failure).

The data revealed that the average number of monthly transactions per traders is 11.6, the proportion of traders who use digital technologies is 51%, the proportions women in the legumes value chain is 81%, and their average age is 45.8 years old. The data also report their levels of education, years of experience in the legumes business, and business size. Interestingly, more than half of the respondents (52%) do not have a formal training or education, about half of them employ 6 to 9 employees (49.9%), and most of the respondents have more than 10 years of experience (90%). Almost all respondents (95.4%) use their mobile phones for calls, while almost half of them (45%) use their phones to navigate on social media. About 30% of respondents use their phones to either trade products and/or to make mobile money transfers. Other DTs such as text messages, internet browsing and YouTube are used by 23.5% of respondents.

These respondents spend substantial amounts of money to purchase the broadband required to use these digital technologies, however. The majority of them (54.1%) spend more than 5,000 CFA Francs every month to purchase internet access. According to official statistics, this represents more than 10% of the average monthly household income in Benin. About 30% of respondents spend between 3,000 and 5,000 CFA Francs, and less than 16% of respondents spend less than 3,000 CFA Francs.

To further the analysis, we divided the sample into two subsamples: the subsample of adopters which includes those that use all the available digital technologies in their android phones (that’s 51% of the whole sample) and the subsample of non-adopters defined as those that use their mobile phones only for phone calls and text messages (that’s 49% of the whole). We found important differences between the two groups. First, adopters tend to have higher digital skills than non-adopters. This can be seen, for example, by comparing the frequencies of respondents in using text messages. Second, DTs users make more monthly transactions and have more employees than their non-adopters counterparts. This suggests that DTs have the potential to initiate transactions and increase employment.

The data collection was successfully completed, despite some difficulties and challenges encountered in the field. The survey revealed that the use of digital technologies is popular in the cereal and legume trade sector and that it provides tangible benefits to users, which was the main hypothesis we set ourselves to test in this project. The survey also revealed that e-commerce apps and online sales are not a common practice among dealers, and the legume value chains in these markets do not feature digital “nomads” (that is, traders who work purely online and do not have a fixed location). But most

respondents expressed the willingness to experiment e-commerce applications that can help improve their businesses including apps such as KasuwaGo.

**Capacity Development:** The survey that we built into our project provides detailed data on the profiles of major players in the grain legume value chains for the selected markets. The data identifies disparities related to issues of gender and youth, as we can measure the size and scales of businesses led by women and youth, as well as the extent and quality of their network connections. In particular, we found that women are the largest dealers in grains and legume markets in Benin (81% of sample), with age range between 22 and 75, and that all of them use mobile phones although only half of them use digital technologies beyond simple calls and texts. The information generated by our surveys can be used to promote opportunities for enhancing participation for the next wave of youth and female actors in the legumes value-chain. The project was also an opportunity for the principal investigators to train a team of enumerators on the field in Benin, to engage in discussions and working sessions with staff and researchers and IITA-Cotonou, and to engage in intellectual activities of which were avenues for capacity building and skills strengthening.

**Lessons Learned:** The primary challenge that we encountered was a technical one beyond our reach. We couldn't get the KasuwaGo app to work properly in Benin, and several communications with the server and the IT teams did not resolve the issue. We therefore had to restrict our study objectives on the broader impact of digital technologies, rather than also focusing it to the specific use of the KasuwaGo app as we initially intended.

The second challenge was the difficulty in pinning down respondents. These are traders and are usually available in their shops only in market days when they are rather busy with customers and cannot devote much time to answer questionnaires. In addition, the majority of them move from one market to another and from one village to another to buy, making it even more difficult to pin them down.

#### **Presentations and Publications:**

Nguimkeu, P. & Olabisi, M. (February 2023). Assessing the Impact of Mobile Technology for Informal Traders in West Africa. Presentation at Global Convening, Livingstone, Zambia

#### **MSI 2.2-2: Exploring Regional Food Hubs in West Africa**

**Locations:** Data from Nigeria (Kano and Ilorin)

**Description:** The project aimed at exploring the nature and function of regional food hubs in West Africa with a focus on Nigerian hubs involved in legume trade. In this context, we define hubs as legume grain trading markets that serve as major regional hubs for traders and utilized network theory to identify markets (or trader hubs) that are both embedded well in their region as well as serve as brokers (or bridges) for other markets in each region.

The project has been a new collaboration between researchers at Michigan State University (MSU) and California State University, Chico (Chico State). Chico State is a minority-serving institution (MSI). Specifically, it is a Hispanic-Serving Institution (HSI) with strong programs in the College of Agriculture.

Project PI, Tatevik Avetisyan, participated and presented at the Legume Systems Innovation Lab Global Convening held in Livingstone, Zambia from February 20-24, 2023. MSU PI Olabisi visited with the Chico State research team from March 24-28, 2023. Multiple research meetings were organized as a research team to discuss research progress and next steps. Research findings will be disseminated through a journal publication. To authors' knowledge, this is the first large scale study exploring grain legume trading market

networks in Nigeria. A similar research approach can be applied to study markets in other West African countries. Additionally, further research can help identify more in-depth characteristics of major hubs identified in the study.

This project aligns with the Feed the Future Innovation Lab's goal of improving the work of the Lab through increased intentional outreach to and engagement of MSIs in the U.S. The project also aligns with one of the main strategic priorities of Chico State: global engagement through scholarly activities. To Avetisyan's knowledge, this was Chico State College of Agriculture's first research project related to West Africa.

**Collaborators:** Tatevik Avetisyan, California State University, Chico, USA. Michael Olabisi, Michigan State University (MSU), USA. Olivia Porcayo, California State University, Chico, USA.

**Achievements:** The team used Nigeria's geopolitical zones (hereinafter zones) as a basis for our regional analyses. The zones are administrative division grouping of Nigeria's states based on similarity of ethnic groups, and/or common political history (not entirely carved out based on geographic location). This approach has been chosen for the study due to the fact that political, education, and economic patterns broadly correspond within the country to the zones.

In social network studies one needs to specify boundaries of a network as well as nodes and ties. The nodes of the regional networks are markets in Nigeria. The data includes markets in which study participants were operating as well as markets in which their trade partners were operating. Each market was assigned a unique identifier code for analysis purposes.

The type of tie under study is a trade relationship between traders in these markets. That is, inter-market connections are the focus of our analysis. The study aims to capture the existence or absence of a trade tie between any two given markets in a network.

To conduct regional analysis, four geopolitical zones were considered for the study, namely, North East, North West, North Central, and South West. The highest number of markets are located in the states of Niger in North Central (N=127), Kano in North West (N=100), and Kaduna in North West (N=75). The average number of markets per state was 35.

Each network is composed of Nigeria markets located in a given zone and markets outside the given zone trading with markets in the given zone. For example, the North East Network is composed of Nigeria markets located in the North East zone and markets outside the North East zone trading with markets in the North East zone.

The project focused on three aspects of market hubs, degree centrality, betweenness centrality, and network density.

Degree centrality is a node-level indicator of how important a node is, measured by how many nodes it is connected to in a given network. (To be clear, a connection is when a trader in one market identifies another market – or a trader based there, as a supplier or customer, so that each link in the network depicts a declared trading relationship in the value chain). The higher the degree centrality, the more connected a node is in a network. In our dataset, the nodes are the markets in Nigeria. Degree centrality will reveal which markets have the highest number of connections with other markets. That is, inter-market connections are the focus of our analysis.

Betweenness centrality measures the extent to which a node (i.e., market) plays a bridging role in a network. The measure was originally proposed by Freeman (1978). Betweenness centrality is defined as the portion of the number of shortest paths (between all pairs of nodes) that pass through the given node divided by the number of shortest paths between any pair of nodes (regardless of passing through the given node) (Abbasi et

al., 2013; Borgatti, 1995). Specifically, betweenness centrality measures the extent that the market falls on the shortest path between other pairs of markets in the network. The more traders depend on a market to make connections with other people, the higher the market's betweenness centrality becomes (Hansen et al., 2020). Nodes with high betweenness centrality are known as *brokers* or *bridges* in a network (Burt, 2005). Brokers form ties (often weak) among nodes that would otherwise be less connected or not connected at all (Hansen et al., 2020).

Network density is a network-level measure. It indicates how many ties between nodes exist compared to how many ties between nodes are possible. It is an indicator of how well connected the nodes are in a given network.

The project helped to identify legume grain trading markets that serve as regional hubs for traders in Nigeria. We utilized network theory to identify markets (or trader hubs) that are both embedded well in their region as well as serve as brokers (or bridges) for other hubs in each region. Research findings will be disseminated by the research team through a journal publication. To authors' knowledge, this is the first study exploring grain legume trading market networks in Nigeria.

The project PIs also plan to continue engaging with stakeholders. Further research can help identify more in-depth characteristics of major hubs identified in the study. Additionally, similar research approach can be applied to study markets in other West African countries.

**Capacity Development:** As stated above, the institutional linkage of Michigan State University and Chico State and the first Chico State research project in West Africa (to PI's knowledge. The student research assistant provide the following statement on the project. "The research project that I am currently working on with Dr. Avetisyan has provided me the opportunity to experience what research is outside of the classroom with actual faculty.... I continue to learn more about West Africa, its culture, and how their food systems work as I dive deeper into the outlines created. Not to mention, the mentorship from Dr. Avetisyan is helpful and accessible whenever I face any question or concern. I can honestly say, this is a great opportunity that has allowed me to apply my learned skills into a job that my journey as an undergrad has helped prepare me for and thus will give me more experience as I search for more post-grad research and career opportunities.

#### **Presentations and Publications:**

Avetisyan, T. & Olabisi, M. (February 2023). Exploring Regional Food Hubs in West Africa. Presentation at Global Convening, Livingstone, Zambia

### **C. Area of Inquiry 3:**

#### **AOI 3.1: How Input Subsidy Policies Change the Cowpea Farming Landscape in West Africa**

**Locations:** Burkina Faso and Mali

**Description:** Policies promoting farm input subsidies on starchy staples and cotton may distort land allocation to cowpeas and reduce crop diversity on farms, with adverse consequences for the resilience of the farming landscape, nutrition, and rural incomes.

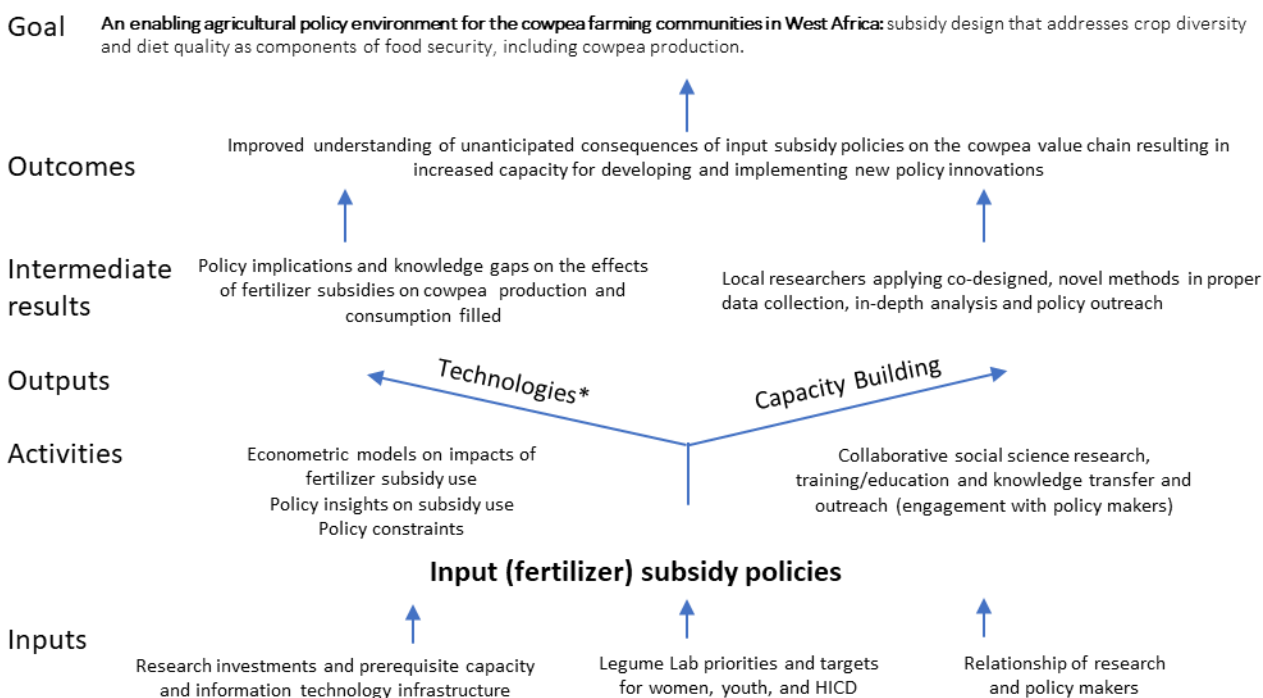
Subsidies may particularly affect the situation of women and young family members who rely on them to meet personal needs. Yet, we know of no empirical evidence on these points in our two study countries and

scant evidence for other countries in a vast literature on economic impacts of fertilizer subsidies in Sub-Saharan Africa.

This project addresses this gap by conducting rigorous analyses with existing large-scale datasets while strengthening the linkages between research and policy formulation as well as supporting the analytical capabilities of young professionals in Mali and Burkina Faso. The research will enhance comprehension of the unanticipated consequences of fertilizer subsidies on the cowpea value chain in Burkina Faso and Mali by examining: 1) the effect of fertilizer subsidies on production diversity (cowpea area shares, plot counts, and spatial indices of crop diversity on farms and villages); 2) the gender- and youth differentiated effects of fertilizer subsidies on cowpea production, quantities sold and revenues; 3) whether on-farm crop diversity or market participation most influences the dietary intake of women of reproductive age.

The project builds capacity through short-term training workshops conducted virtually in each country and through involvement of six students, four of whom are women, in MSc and PhD degree training advised by local co-PIs.

### Theory of Change and Impact Pathways(s):



This TOC begins with a goal of helping foster an enabling agricultural policy environment for the cowpea farmers and households in the Sahelian countries of West Africa: Burkina Faso and Mali. This policy environment promotes the strategic use of input subsidy and realigned fertilizer subsidies that addresses crop diversity and diet quality as components of food security, including cowpea production. The contribution of this project “How Input Subsidy Policies Change the Cowpea Farming Landscape in West Africa” to this goal depends on data and information it generates that will understand the effect of fertilizer subsidies on production diversity, production, sales and income, and dietary intake. This can be achieved through helping address knowledge gaps and policy implications on the effects of fertilizer subsidies on cowpea production and consumption and ensuring that its capacity building efforts result to local researchers applying co-designed, novel methods in proper large dataset collection, in-depth analysis and policy outreach. A critical part of this project is the creativity in involving diverse stakeholders and other decision makers that can help in the subsidy reforms. This project capitalizes on large-scale databases, and local knowledge base on the use and effects of input subsidies. Success will depend on critical inputs, including research investments, prerequisite research capacity and ICT infrastructure, priorities and targets by the Legume Lab, and interaction of research communities with policy makers.

**Collaborators:** Melinda Smale, Michigan State University, USA. Veronique Theriault, Michigan State University, USA. Eugenie Maiga, Université Norbert Zongo, Burkina Faso. Bourema Kone, Institut d'Economie Rurale, Mali.

**Achievements:** -- The project concluded in FY2022, resulting in five publications in peer-reviewed journals, 2 manuscripts in review, 3 MSc theses completed by students in Mali and Burkina Faso, one working paper applying the Kaleidoscope Model, and one stakeholder workshop. The project team undertook a case study utilizing the Kaleidoscope Policy Model (KM) and continued to support work undertaken by students in preparation of their theses. The team also further developed two papers on gender analyses.

**Capacity Development:** The Mali team was able to engage an array of knowledgeable decision makers about the fertilizer subsidy. The team brought together stakeholders around the findings of the KM policy case study supported open exchange of opinions and ideas. Students have prepared posters on their work and a lightning presentation for the Annual Convening of the Legume Systems Innovation Lab. One student in Mali and two in Burkina Faso have completed their MSc thesis supervised by local co-PIs. The local co-PIs co-authored several of the project journal publications.

#### **Lessons Learned:**

Completing student theses in a two-year project lifetime is not always feasible. This can be due to external factors such as COVID-19 or personal student limitations.

Stakeholders were open and provided an exchange of opinions and ideas when invited to discussions on the findings of the KM policy case study.

The lesson to be learned with this research is that fertilizer subsidies can have a negative impact on other crops.

In Mali, cowpea has been generally regarded as a women's crop. However, research has indicated that cowpea is not a women's crop per se but that cowpea products are a women's enterprise. Flushing out facts from assumptions with data-driven research can improve the success of future interventions by targeting the right stakeholders.

**Presentations and Publications:** No publications in FY2023

## **D. Commissioned Research Projects<sup>2</sup>**

### **CA 2: Genetic Improvement of Dry Beans for Bruchid Resistance for Southern Africa.**

**Locations:** Malawi, Mozambique, and Zambia

**Description:** The Southern Africa countries of Zambia, Malawi, and Mozambique have some of the highest levels of poverty and malnutrition worldwide. Agriculture is an important economic activity and among all the crops grown, common bean (*Phaseolus vulgaris* L.) is one the staple crops in terms of both production and consumption. Southern Africa accounts for ~32% of the total production of common bean in the continent. Despite the economic and nutritional importance, seed yields remain low. Both biotic and abiotic stresses are the main causes of significant losses.

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<sup>2</sup> In FY2020, the first Commissioned Project concluded. Commissioned Projects Two – Five are ongoing in FY2021.



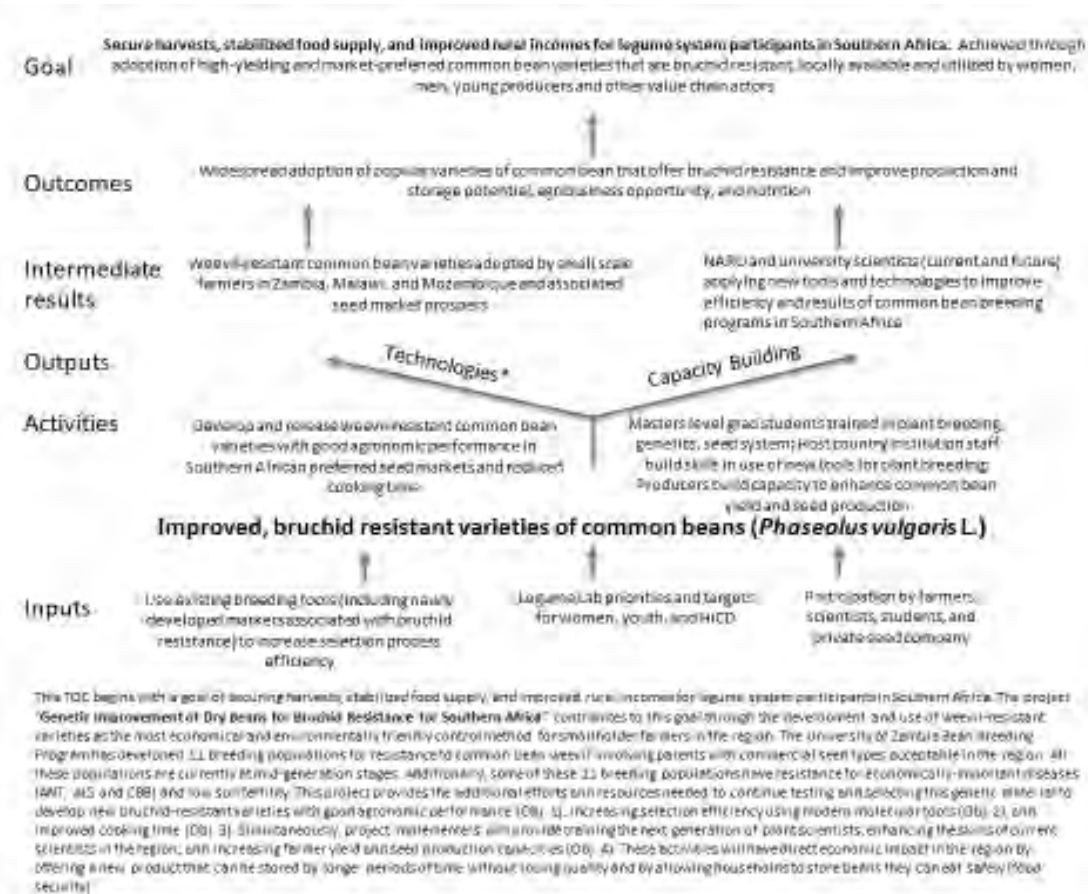
In addition, bruchids or bean weevils *Acanthoscelides obtectus* (AO) are a post-harvest pest responsible for over 48% of losses in quality and quantity of common bean in storage. Only recently, have breeders been able to develop germplasm with resistance to the 2 main species of bruchids. This represents a new and unique opportunity to transfer the resistance (known as the APA locus) into commercial varieties with good agronomic performance and well accepted in this region. Insecticides are available but may be expensive and some are toxic. Also, chemical control is less practiced in Africa because farmers may not be able to afford pesticides.

Therefore, development and use of weevil-resistant varieties would be the most economical and environmentally friendly control method for smallholder farmers in the region. The University of Zambia Bean Breeding Program has developed 11 breeding populations for resistance to common bean weevil involving parents with commercial seed types acceptable in the region. All these breeding populations are currently at mid-generation stages. Additionally, some of these 11 breeding populations have resistance for economically important diseases and low soil fertility.

This project aims to continue testing and selecting this genetic material to develop new bruchid-resistant varieties with good agronomic performance, increasing selection efficiency using modern molecular tools, and improved cooking time. These activities will have direct economic impact in the region not only by offering a new product that can be stored for longer periods of time without losing quality, but also allowing households to store beans they can eat safely (food security).

In addition, the project will improve the technical knowledge of bean smallholder farmers, bean scientists, and other stakeholders in the region through training the next generation of plant scientists (breeders) for the region.

## Theory of Change and Impact Pathways(s):



**Collaborators:** Juan Osorno, North Dakota State University, USA. Phillip McClean, North Dakota State University, USA. Carlos Urrea, University of Nebraska-Lincoln, USA. Kelvin Kamfwa, University of Zambia, Zambia. Virginia Chisale, Department of Agricultural Research Services, Malawi. Celestina Jochua, Instituto de Investigação Agrária de Moçambique (IIAM), Mozambique.

**Achievements:** At least two breeding lines are currently being considered for commercial release. Weevil resistant breeding lines in market classes preferred in Malawi, Mozambique and Zambia have been developed and shared with the national programs in Malawi, and Mozambique. These breeding lines are currently being evaluated for agronomic performance in the three target countries.

The 16 AO-resistant breeding lines were evaluated for cooking time using the Mattson cooker. Breeding lines with the ideal combination of weevil resistance and faster cooking time were identified. The 16 AO-resistant lines were evaluated for agronomic performance in preliminary yield trials. Weevil-resistant breeding lines with higher productivity were identified.

An InDel marker ( $\alpha$ -AI) was validated for use in Marker-Assisted Selection (MAS). This marker showed 100% prediction accuracy for the weevil resistance phenotype and can be used in MAS for weevil resistance to circumvent the lengthy period required for phenotyping for AO resistance.

Additional testing of the most resistant and promising lines was carried out in Malawi, Mozambique, US, and Zambia. Three molecular markers have been validated and 1 of them showed 100% accuracy in detecting the resistance from the original source AO3. Additional potential sources of bruchid resistance have been identified by screening additional germplasm from the Andean Diversity Panel (ADP). In addition, some lines with Anthracnose resistance have also been identified.

**Capacity Development:** The project has trained four female next-generation breeders in plant breeding at the master's level. One student from Zambia was trained at North Dakota State University, and the other three from Malawi, Mozambique, and Zambia were trained at the University of Zambia in the Plant Breeding and Seed System master's program. This graduate training has strengthened common bean research capacity for the national breeding programs in Malawi, Mozambique, and Zambia.

Furthermore, several undergraduates, research interns, and technicians in Malawi, Mozambique, and Zambia have been trained in conducting weevil resistance, cooking time, and field trials. This training will be critical to sustaining breeding efforts for weevil resistance in breeding programs in the three target countries.

The project also provided an opportunity for the UNZA breeding program to meaningfully collaborate with the private sector, specifically Good Nature Agro (GNA), to ensure that the weevil-resistant varieties developed by the project are scaled-up in production and distribution to farmers.

**Lessons Learned:** Seed multiplication rates continue to be challenging in Zambia and other countries. Additional efforts will be carried away in order to ensure larger seed quantities of the lines selected as potential cultivar releases.

#### **Presentations and Publications:**

Osorno, J. M., Urrea, C., Kamfwa, K., & Mazala, M. (June 2023). [In Spanish]: Evaluación del Tiempo de Cocción de Líneas Andinas de Frijoles con Resistencia a los Brúchidos en el Sur de África. Presentation at PCCMCA, Antigua, Guatemala

McClean, P. E., Osorno, J. M., Urrea, C., Kamfwa, K., & Mazala, M. (June 22, 2023). AGRONOMIC AND COOKING CHARACTERISTICS OF COMMON BEAN GENOTYPES WITH BRUCHID RESISTANCE AND MOLECULAR MARKER VALIDATION. North Dakota State University

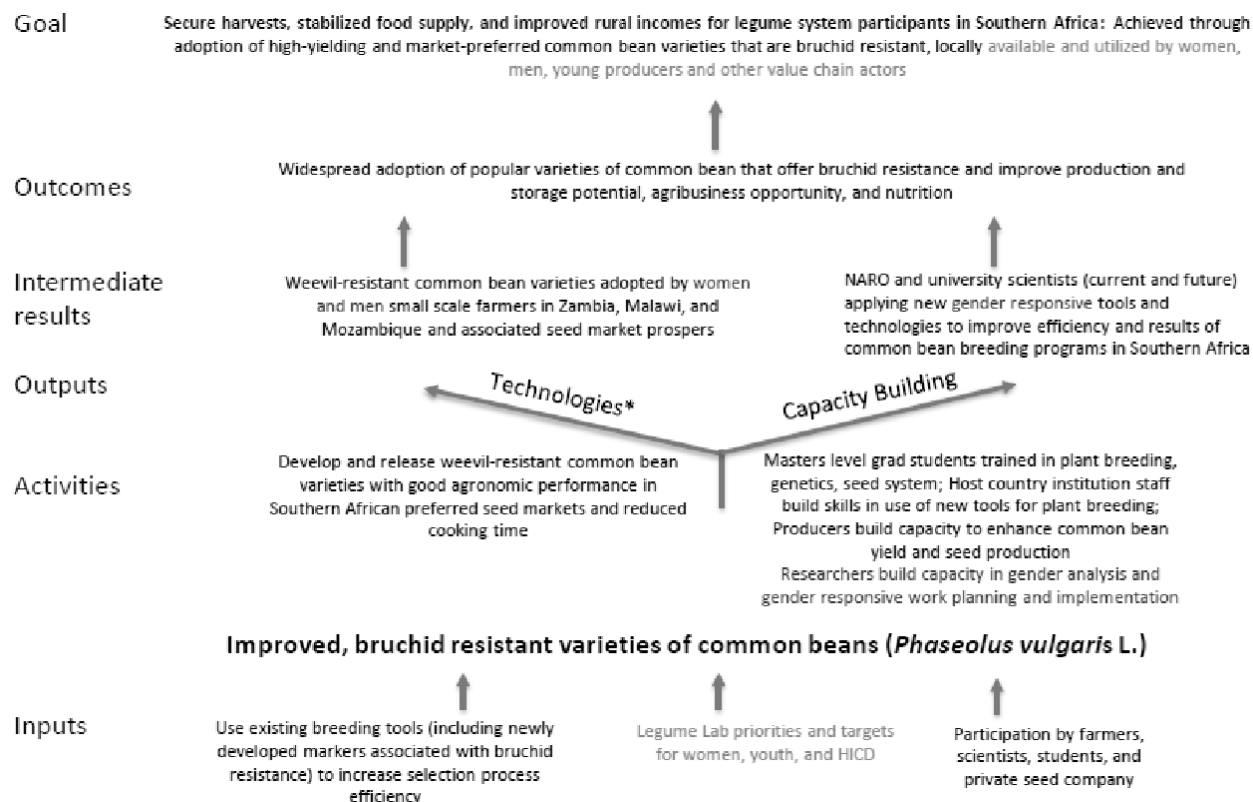
#### **Strategic Collaborations: Implementing a Gender-Responsive Genetic Improvement Program for Bruchid Resistant Dry Beans in Southern Africa**

**Locations:** Malawi, Mozambique, and Zambia

**Description:** This project, in collaboration with the CA2 project team, will allow a deeper dive into the details of participatory processes and producer preferences within each country, including application of the new gender responsive (G+) tools recently pilot tested by the CGIAR Gender Breeding Initiative. The CGIAR Gender Breeding Initiative brings together plant and animal breeders and social scientists to develop a strategy for gender-responsive breeding with supporting methods, tools, and practices. As a result, researchers will be able to define product profiles and customer segments more effectively and better understand gender differentiated constraints, opportunities, and preferences throughout the breeding program. Of particular interest will be learning why, after initially balanced participation, women's involvement has generally decreased over time as a breeding initiative nears variety release and product multiplication stages.

The activities under this project will set the foundation for continued enhancement of the breeding program at each participating institution through 1) the increased capacity of participating researchers; 2) documentation of the capacity development and research process and outcomes in a case study; 3) generation of lessons learned and associated guidance for further institutionalizing these processes in the years ahead. Ultimately, research findings will contribute to more effective achievement of the overall breeding programs' end goal: the increased food security and nutrition through adoption of bruchid resistant common bean varieties available and utilized by women, men, young producers and other value chain actors.

### Theory of Change and Impact Pathways(s):



**Collaborators:** Kelvin Kamfwa, University of Zambia, Zambia. Crisanty Charam, Zambia Agriculture Research Institute (ZARI), Juan Osorno, North Dakota State University, USA. Phillip McClean, North Dakota State University, USA. Carlos Urrea, University of Nebraska-Lincoln, USA. Virginia Chisale, Department of Agricultural Research Services (DARS), Malawi. Hilda Kabuli DARS, Celestina Jochua, Instituto de Investigação Agrária de Mozambique (IIAM), Mozambique. Maria da Luz Quinhento IIAM, Krista Isaacs, Michigan State University (MSU), and Andrea Allen MSU.

**Achievements:** Since beginning in May 2021, the team has searched and reviewed existing quantitative and qualitative studies and data to identify those data needed to define market segmentation, priority targets, and customer profiles for Zambia, Malawi and Mozambique. The project has built capacity for gender-responsive breeding in the public breeding programs of the three HC. The skills and information that breeders have acquired from the project will be important in ensuring that as the programs are setting breeding objectives, they incorporate traits that women prefer. This will promote faster adoption of newly developed varieties by women and reduced drudgery. The project has provided important information to support future interventions to enhance women participation in common bean production. The information on some of the factors that potentially impede variety adoption by women from the project will be shared with organizations such as PABRA and CIAT. These organizations could then use this information to integrate gender-

responsive breeding in the case of CIAT or encourage breeding programs under PABRA to integrated gender-responsive breeding. This could result in addressing varietal needs of women common bean farmers and enhance women participation in common bean production.

Furthermore, farmer participatory varietal selections (PVS) were conducted to identify specific traits that women or men rank highly when choosing a variety. The survey and focus group discussions provided descriptive statistics on agro-ecological and socio-economic segmentation in Malawi, Mozambique and Zambia. Additionally, the surveys provided information on gender differences in preferences for common bean trait. Furthermore, five bruchid resistant breeding lines were evaluated using farmer participatory variety selection conducted on an on-farm trial in Malawi, and PVS was conducted to evaluate ten bruchid resistant lines planted on-station in Mozambique

From this review, the project has identified gaps needing additional research. The research team used existing data to construct G+ Customer Profiles related product map, customer map, evidence table, and customer segments to be targeted for Zambia, Malawi, Mozambique. As a result, the team determined significant gaps in gender disaggregated data and analysis related to demographic, socio-economic, and agroecological data for common beans in all Zambia, Malawi, Mozambique. These preliminary findings support earlier assertions that data collection and analysis generated by the team's work will make an important contribution to filling those gaps.

The project has provided enduring, collaborative linkages among participating organizations (especially between breeders and social scientists) in the three countries. These linkages will be vital to mainstreaming gender in the public breeding programs in the three countries.

**Capacity Development:** There has been increased capacity for gender responsive breeding via the experiential learning gained through G+ tool application among breeders and gender experts in the three host countries.

#### **Presentations and Publications:**

Chisale, V. & Kabuli, H. (February 2023). ASSESSING GENDER RESPONSIVE PREFERENCES OF BRUCHID RESISTANT BEAN VARIETIES IN MALAWI. Feed the Future Innovation Lab for Legume Systems Research - Global Convening, Livingstone, Zambia

### **MSI CA2: Development and Release of Bean Cultivars for Central America and the Caribbean having Multiple Virus and Bruchid Resistance**

**Locations:** Puerto Rico and Honduras

**Description:** The common bean weevil (*Acanthoscelides obtectus* Say.) and the Mexican bean weevil (*Zabrotes subfasciatus* Boheman) are important post-harvest pests for bean producers in Central America and the Caribbean (CA/C). The potential damage caused by the weevil often forces farmers to sell their crop shortly after the harvest when prices tend to be the lowest and limits the ability of farm families to store seed for domestic consumption and for planting the next crop of beans. In recent years, the bean research programs at the University of Puerto Rico, Zamorano University and the USDA-ARS Tropical Agricultural Research Station have collaborated in the breeding and selection of common bean breeding lines for Central America and the Caribbean that combine bruchid resistance and resistance to multiple viruses of regional importance including Bean Golden Yellow Mosaic Virus (BGYMV), Bean Common Mosaic Virus (BCMV) and Bean Common Mosaic Necrosis Virus (BCMNV). Resistance to BCMV and BCMNV is also important in Eastern and Southern Africa where these seed-borne viruses are endemic. The Intertek SNP marker platform allows breeders to send desiccated seed embryo tissue samples to a laboratory for the extraction of DNA and screening with molecular markers at a modest cost per sample. The project goals and objectives were 1:

Develop, test and release Mesoamerican common bean varieties for Central America that combine multiple virus and bruchid/weevil-resistance. 2) Identify novel sources of resistance to the common bean weevil. 3) Evaluate the performance of the lines selected in Zambia and Puerto Rico for bruchid resistance when screened with the Mexican bean weevil and a Caribbean biotype of the common bean weevil. 4) Research techniques and information for the Bean Improvement Cooperative web site and informal training of CA/C researchers.

**Collaborators:** Abiezer González, University of Puerto Rico, Mayagüez, USA. James Beaver, University of Puerto Rico, Mayagüez, USA Timothy G. Porch, USDA-ARS Tropical Agricultural Research Station, Mayagüez, USA. Juan Carlos Rosas, Zamorano University, Honduras.

**Achievements:** The project provided valuable support for the following activities:

- The first release of bruchid resistant Mesoamerican bean germplasm lines PR1303-129 (black) and PR1743-44 (small red) combine multiple virus and bruchid resistance. On-farm testing of PR1743-44 accelerated the collection of data needed to formally release this line as a cultivar.
- Advanced generation Mesoamerican (black, small red and white) from the most recent cycle of selection were developed that combine bruchid and virus resistance with improved seed yield potential and greater tolerance to high temperatures.
- The Intertek SNP marker platform was used to aid in the selection of bean breeding lines for disease resistance. The marker data accelerated the breeding process and improved the efficiency of selection of multiple traits.
- Breeding populations were developed using novel sources of bruchid resistance in wild tepary beans with the eventual goal of introgressing this resistance into common beans.
- A document was prepared that identifies bean germplasm and describes research techniques that have been successful for breeding beans for bruchid resistance. This information will be posted on the Bean Improvement Cooperative web site.
- The project strengthened ongoing collaboration with the Legume Systems Innovation Lab project entitled ‘Genetic Improvement of Dry Beans for Bruchid Resistance for Southern Africa’ at North Dakota State University. Bruchid resistant Andean bean breeding lines from Zambia were identified that were also resistant in Puerto Rico to the common bean weevil.

**Capacity Development:**

**Lessons Learned:**

**Presentations and Publications:**

Porch, T. & Osorno, J. (February 2023). Development and release of bean cultivars for Central America and the Caribbean having multiple virus and bruchid resistance. Feed the Future Innovation Lab for Legume Systems Research - Global Convening, Livingstone, Zambia

Beaver, J. (June 2023). [In Spanish] Selección asistida por marcadores moleculares de frijol para combinar genes de resistencia al virus y a la roya. Presentation at PCCMCA, Antigua, Guatemala.

Gonzalez Velez, A. & Beaver, J. (June 2023). [In Spanish] Selección asistida por marcadores para identificar líneas de frijol con múltiples resistencias. Presentation at PCCMCA, Antigua, Guatemala.

**CA 3: Sustainable Intensification of Dual-Purpose Cowpea Varieties for Enhanced Food and Fodder in Senegal**



**Locations:** Senegal (Louga, Kafrine, and Diourbel)

**Description:** Forage availability for livestock is a major limitation for agro-pastoral systems in semiarid regions in sub-Saharan Africa. Substantial research has been conducted to develop dual-purpose (i.e., grain and fodder), nutrient dense, cowpea cultivars (e.g., Lizard, Leona, Kelle, and Sam) for the peanut basin in Senegal. The new cultivars have “stay green” properties at maturity for improved fodder quality, and are tolerant to heat stress, which is ideal for production in the targeted regions of this research.

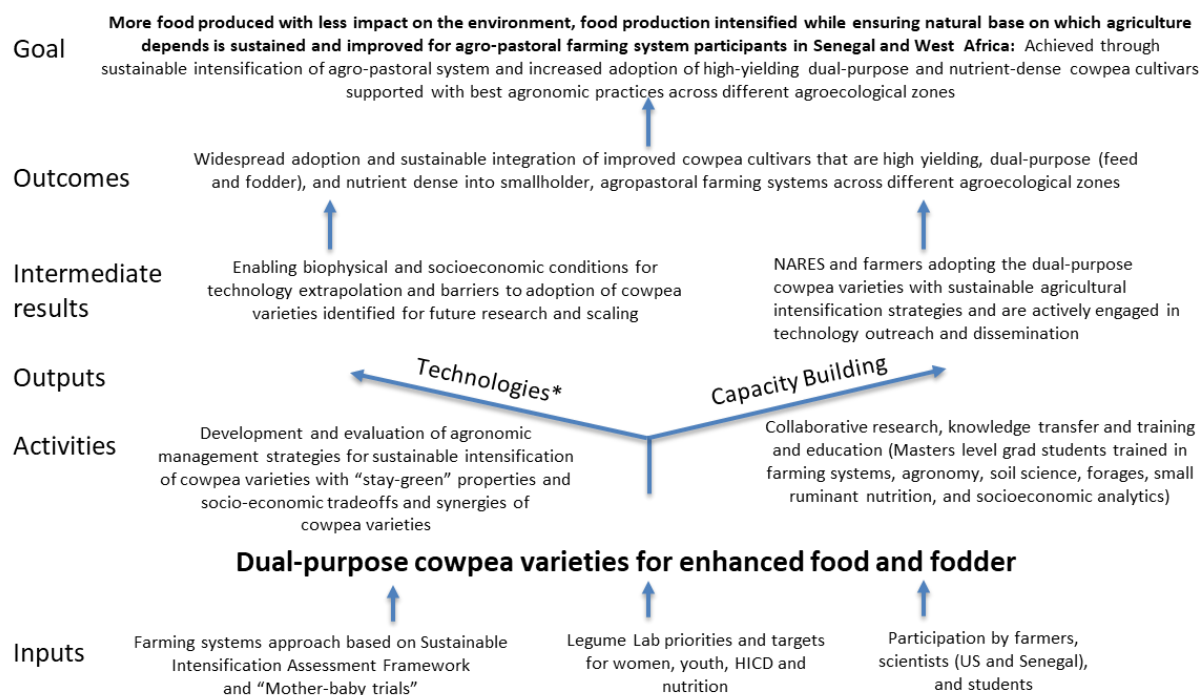
These new cowpea varieties have been available in Senegal only recently and best agronomic management practices and both productivity and economic performance in traditionally pastoral or cowpea cultivating areas has not been considered. Improved genetics paired with appropriate agronomic management and an understanding of socioeconomic tradeoffs is critical for driving dissemination and adoption by farmers with the ultimate goal of improving resilience, nutrition and food security of Senegalese smallholder farmers.

This project develops and evaluates agronomic management strategies for the sustainable intensification of dual-purpose cowpea (i.e., increased food, fodder quantity, and quality on the same land area) into smallholder agro-pastoral farming systems across the peanut basin in Senegal. The study uses a multidisciplinary, farming systems approach based on the Sustainable Intensification Assessment Framework (SIAF) ([www.sitoolkit.com](http://www.sitoolkit.com)) and a participatory research model (i.e., “mother-baby trial”) to collect robust biophysical farming systems and socioeconomic data to identify enabling conditions for technology extrapolation and barriers to adoption that can guide future research and scaling.

Specific research objectives are 1) evaluate the dual benefits of cowpea varieties to increase both grain and fodder quantity and quality and 2) conduct a tradeoff assessment for cowpea markets with particular focus on tradeoffs and synergies between grain and fodder production in areas that are traditionally pastoralists compared to areas that traditionally grow cowpea.

Human and institutional capacity development will be integrated throughout with significant allocation of resources to both long-term graduate student training and short-term skill-transfer trainings.

## Theory of Change and Impact Pathways(s):



This TOC begins with a goal of more food produced with less impact on the environment, food production intensified while ensuring natural base on which agriculture depends is sustained and improved for agro-pastoral farming system in Senegal and West Africa. The contribution of this project: **Sustainable Intensification of Dual-Purpose Cowpea Varieties for Enhanced Food and Fodder in Senegal** to this goal depends on the widespread adoption and sustainable integration of improved cowpea cultivars that are high yielding, dual-purpose (feed and fodder), and nutrient dense into smallholder, agropastoral farming systems across different agroecological zones. Driving wide acceptance from the agro-pastoral system, and sustainably intensifying the system will be based on research evidence and information that identifies minimizing tradeoffs and maximizing synergies across biophysical and socioeconomic domains including productivity, economic, environmental, human and social domains. Through collaborative research, this project will develop and evaluate the agronomic management strategies for the sustainable intensification of dual-purpose cowpea, promote knowledge transfer and implement human and institutional capacity building to train future researchers on sustainable agricultural intensification for enhanced food and fodder production. This project builds on past research, i.e. Sustainable Intensification Assessment Framework, and established approaches, i.e. mother-baby trials, existing collaborations, and resources from previous USAID funded projects and current support from the Legume Lab. Success will depend on prerequisite research capacity and infrastructure, priorities and targets by the Legume Lab, and participation by farmers on the mother-baby trials.

**Collaborators:** Augustine Obour, Kansas State University, USA. Aliou Faye, ISRA-CERAAS, Senegal. Madam Dieye, ANCAR, Senegal. Moussa Diangar, ISRA, Senegal. Assane Baye, Université Cheikh Anta Diop de Dakar (UCAD), Senegal. Doohong Min, Kansas State University, USA. Yacob Zereyesus, Kansas State University, USA. Vara Prasad, Kansas State University, USA.

**Achievements:** This project determined the best dual-purpose cowpea varieties for the three agro-ecological zones in the Senegalese peanut basin using net revenue from sales of both grain and fodder. The best cowpea varieties for dual-purpose use in Bambey were Melakh, E-BC4STR1 &5, Pakaw, Mouride, Sam, Kelle, and Leona. The best varieties in Boulel were Leona, Mougne, Melakh, 66-35F, Sam, Kelle, and Thieye. The best varieties in Darou Mousty were Leona, Melakh, Kelle, Pakaw, E-BC4STR1, Kelle, Sam, Thieye, and 66-35F. The cooking time of dual-purpose cowpea varieties was similar to the older variety Yacine. However, grain protein, iron and zinc concentrations of the dual-purpose varieties including Leona, Kelle, Lizard, Thieye, and Sam were greater than Yacine. Soil analysis results showed soil total nitrogen was low (0.06%), soil organic matter (0.3-0.6%), and phosphorus (0.5 -0.9 ppm) concentrations were very low across environments. However, incorporating cowpea residue in the soil improves soil phosphorus concentration and cation exchange capacity. Applying fertilizer in combination with cattle manure in 2021 had no effect on cowpea yields in Louga but increased fodder and grain yields by 18-42% in Dioubel and 24-51% in Kaffrine. In 2022, manure plus fertilizer application increased cowpea fodder and grain yields by 21-43% in Dioubel, 78-84% in

Kaffrine and 66-53% in Louga region. Findings of the socioeconomic analysis showed adoption of dual-purpose cowpea had little effect on labor required but resulted in greater fodder production compared to Yacine. Over 95% of participants in the on-farm trials showed willingness to pay for seeds of dual-purpose cowpea. Approximately 30% of farmers increased cowpea grain yields while 58% obtained more fodder and 51% of farmers indicated their standard of living has improved through the sales of fodder from dual-purpose cowpea varieties.

**Capacity Development:** The project collaborates with the Institut Sénégalais de Recherches Agricoles (ISRA); Senegal national Agency for Extension and Advising (ANCAR), Feed the Future Sustainable Intensification Innovation Lab; Faculté des Sciences Economiques et de Gestion (FASEG), Université Cheikh Anta Diop of Dakar. A graduate student from Senegal completed a 9-month exchange scholar program at Kansas State University. The student was trained in using NIRS in developing calibration equations for dual purpose cowpea forage quality analysis. He also gained experience in dryland cropping systems and soil management research. Upon return to Senegal this skill set will be very useful to ISRA in forage nutritive value analysis and cropping systems research. Currently have three MSc students at Cheikh Anta Diop de Dakar (UCAD), one post-doctoral scientist working on the project. Six undergraduate students' assistants helping with the socioeconomic data collection on cowpea utilization, fodder and grain markets. The co-PI Dr. Aliou Faye visited Kansas State University Agricultural Research Center-Hays in April 2022 and May 20223 on a short scientific exchange program. This offered Dr. Faye the opportunity to learn about soil management and dryland cropping system research conducted on KSU experimental fields and producer farms across western Kansas. The lead PI, Dr. Obour assisted collaborating ISRA scientists in designing detailed field experimental protocols, revising data collection methods to ensure stronger research outputs. This has improved quality of data collected. From 120 to approximately, 150 Smallholder famers (25-30 farmers participants each from Louga Louga, Diourbel, and Kaffrine regions in both 2021 and 2022) and 4 local extension officers participated in the baby-trials had direct training on best management practices (sowing rate, spacing and fertilizer management) of dual-purpose cowpea compared to famer practice).

Conducted two fields' days in October 2022 in Darou Mousty and Bouel. More the 50 farmers attended each field day even. Offered undergraduate internships for 3 students, one student per experiment location. Hired 10 to 15 youth at each location to assist with laying of plots and data collection activities. These individuals had hands of training in growing and managing dual-purpose cowpea in the field. Two students attended the Legume Systems Innovation Lab Global Convening in February 2023 in Livingstone, Zambia. This provided an opportunity to present their research and interact with scientists in the global legume research community.

**Lessons Learned:** Availability of cowpea seeds was a major challenge to large-scale adoption of new and improved cowpea varieties. Farmers participating in the on-farm baby trials indicated they are willing to pay 300 to 3500 CFA for seeds of dual-purpose cowpea varieties if available. We observed most cowpea and other crops were grown in highly depleted soils with total nitrogen ranging from 0.05 to 0.06%, soil organic matter content of 0.3 to 0.6%, average nitrogen content of 0.06% and phosphorus concentration ranging from 0.54 to 1.02 ppm. Weed management was another agronomic management issue that impact yields. Farms were abandoned over the growing season because of weed pressure. In general, there is little agronomic and cropping systems research within ISRA. More cropping systems research are needed to fine tune crop residue management, soil health, varietal selection, improved crop rotations, weed management, and soil fertility to increase yields. There is limited institutional capacity in forage, soil, and plant analysis in Senegal. When available, prices were cost prohibitive, or the laboratory was overwhelmed which resulted in delays in getting samples analyzed timely.

#### **Presentations and Publications:**

Obour, A. K., Faye, A., Beye, A., Stewart, Z. P., Min, D., & Prasad, V. (November 2022).  
Adaptability of dual-purpose cowpea for grain and fodder production in semi-arid regions of West

Africa. Presentation at InterDrought 2022. The 7th Congress on Plant Production in Water-Limited Environment., Dakar, Senegal.

Tine, S., Faye, A., Obour, A., Diouf, D., Ndiaye, J. B. M., Lo, M., Akplo, T. M., Ndiaye, S., & Assefa, Y. (July 2023). Cowpea residue management effect on productivity of subsequent millet in a legume-cereal crop rotation(pp.20413). *Agrosystems, Geosciences & Environment*, 6, Hoboken, New Jersey (Peer reviewed).

Akplo, T. M., Faye, A., Obour, A. K., Stewart, Z. P., Min, D., & Prasad, V.. Dual-Purpose Crops for Grain and Fodder to Improve Nutrition Security in semi-arid Sub-Saharan Africa: A review.. *Food and Energy Security*.

Ndiaye, B. M., Obour, A. K., Faye, A., Akplo, T. M., Stewart, Z. P., Min, D., & Prasad, V. (November 2022). Improving Food and Nutrition Security through the Integration of Dual-Purpose Cowpea Varieties in the Agro-Pastoral Farming System in Senegal. Presentation at ASA, CSSA, SSSA International Annual Meeting, Baltimore, MD

Ndiaye, B. M., Obour, A. K., & Faye, A. (August 2023). Predicting Nutritional Quality of Dual-Purpose Cowpea Using NIRS and the Impacts of Crop Management(pp.doi.org/10.3390/su151612155). *Sustainability*, 15(12155), Basel, Switzerland (Peer reviewed).

Baye, A., Diakhate, P., Diouf, O., Faye, A., Obour, A.... (November 2022). Socio-economic constraints of adopting new cowpea varieties in three agro-ecological zones in the Senegalese peanut basin(pp.14550). *Sustainability*, 14, Basel, Switzerland (Peer reviewed).

#### **CA 4: Transforming Seed Systems to Respond to Bean Variety Demand Through Multi-Stakeholder Platforms in Malawi**

**Locations:** Malawi (Mzimba, Dedza, and Kasungu)

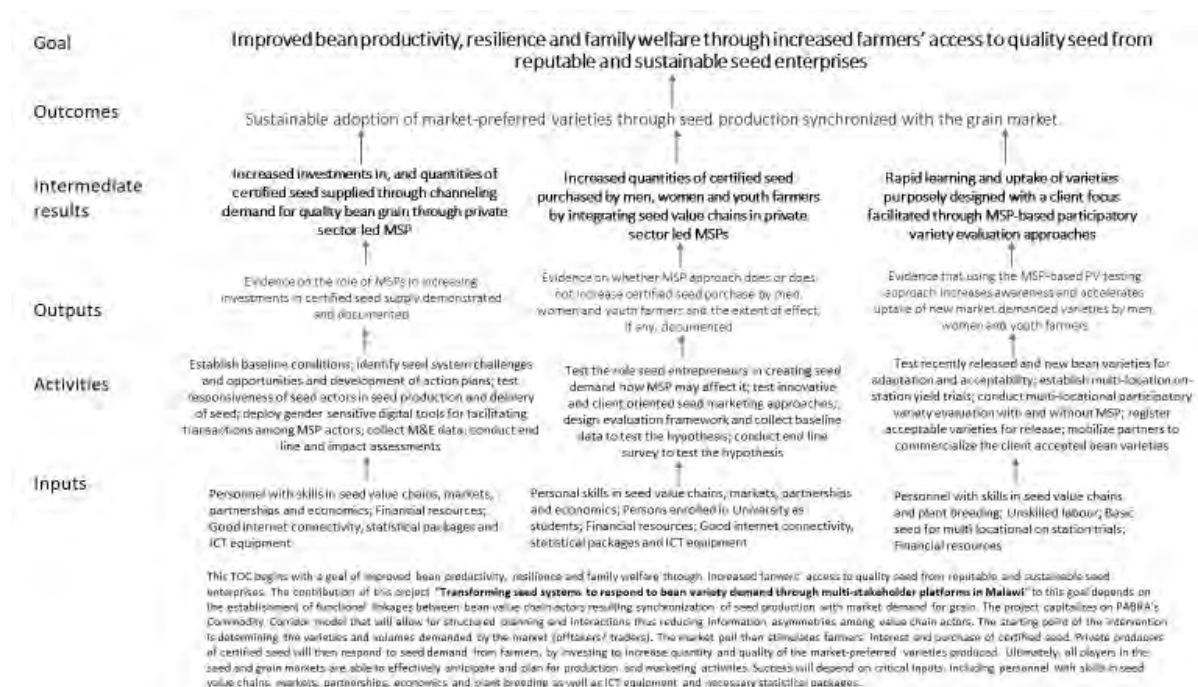
**Description:** Bean seed production and supply systems in Africa - including Malawi - experience several challenges, which inhibit reliable and continuous access of varieties to farmers. One of the key challenges is lack of value chain coordination starting from the market demand for grain that influences demand for certified, basic and breeder seed, and ultimately feeding into the breeding pipeline. The lack of structured planning and interactions among value chain actors results in uninformed seed players on the value of the varieties and the inability to anticipate and plan for production and marketing activities. Ultimately, farmers do not have access to relevant varieties through the formal sector. Subsequently they use part of their saved grain as seed, resulting in lower yields. Although beans are increasingly becoming a commercial crop, with grain off-takers interested in specific varieties, these off-takers are often not connected to the certified seed pipeline and bean breeding programs. They source low quality grain from farmers at low prices, which discourages farmers from investing in the purchase and use of certified seed.

To address these challenges, the Pan-Africa Bean Research Alliance (PABRA) has tested a number of partnership approaches along the bean value chain. The most recent one, the Corridor Approach where the market pull incentivizes farmers to use improved consumer preferred varieties, and this drives up the demand for seed. It is hypothesized that a sustainable adoption of market-preferred varieties can be achieved if the commercialization approach makes deliberate efforts to synchronize and closely link seed production to grain market. This requires commitment from all participating value chain actors, which can be achieved through integrating the seed system in a multi stakeholder platform (MSP). MSPs are “spaces” for learning and knowledge exchange whereby a group of stakeholders come together to diagnose problems, identify opportunities and find ways to achieve their mutual goals and benefits (Homann-Kee Tui et al. 2013; Schut

et. al, 2018). The MSP facilitates linkages among actors of grain markets that in turn pulls seed demand and production.

The objective of this study is to test how a market pull for demanded varieties through the MSP context can stimulate farmers' interest and purchase of certified bean seed. Private producers of certified seed will then respond to seed demand from farmers, by investing to increase quantities and quality of seed supplied, the number of farmers accessing seed, and ultimately increase bean productivity and production.

### Theory of Change and Impact Pathways(s):



**Collaborators:** Jean Claude Rubyogo, Alliance of Bioersivity International and CIAT (Alliance), Kenya. Mthakati Alexander R. Phiri, Lilongwe University of Agricultural and Natural Resources (LUANAR), Malawi. Virginia Chisale, DARS, Malawi. Eliud Birachi, Alliance, Rwanda. Enid Katungi, Alliance, Uganda. Rowland Chirwa, Alliance, Malawi.

**Achievements:** The first cohort of MSc students completed writing of their thesis and submitted them for final examination at their university faculties. During the same period, the second cohort of MSc students were recruited and completed drafts of their research proposals, which were awaiting clearance from their department. They have embarked on reviewing data collection tools that will be used to collect data that will serve the purpose of meeting their research needs but also the project's final evaluations and testing of the project hypotheses. The three new students are linked to the three project objectives. Digital tools to support trading and communications on the MSPs were designed and are being tested by MSP and other partners after being validated by the MSP partners. In February 2023, project used the opportunity at the Global Convening in Livingstone, Zambia to share project experiences, lessons and research results through 9 presentations that were made by the project members. Variety demand creation continued through more than 100 demonstration plots set up. Participatory variety evaluations with more than 246 participants (128 female) were also conducted based on the 10 new and 5 recently released varieties. Three varieties have been prioritized to be released as a result of the evaluations. Preliminary results on the objectives shows that MSPs are positively impacting on dollar amounts invested in seed supplies, entry costs into seed supply enterprises. In addition, the willingness to pay for certified seeds is correlated with participation in MSPs, besides other

factors (sex, market, prices) demand for seeds differs among men and women. Finally, the potential of MSP to promote the new varieties in a faster manner than outside the MSP framework has been demonstrated.

Results on seed supplies indicated that more significant investments in certified seed production were realized in MSP areas, increasing availability and access to seeds of different classes. The project's successful engagement with local farmers through the platform led to increased awareness and understanding of the benefits of the new common bean varieties and established demand for the varieties and seeds much faster than when multistakeholder platforms were not involved. The number of seed companies investing in seed supplies and quantities produced and supplied significantly increased in the bean value chain. There was also an evolving seed and grain market on the MSPs and digital extension and market trading systems as part of new investments. The results on seed demand indicated a significant difference in the amount of money invested into certified seed input for production between the counterfactual area and intervention area, which was significant at the 5% level with the t-test value of -2.3893. The mean amount of money invested in seed input for seed multiplication was about MK47,273 in the intervention area, while the counterfactual was MK22,550. Thus, this suggests that common bean farmers in the intervention area invested more income in seed input for multiplication than those in the counterfactual sites. Results provide evidence that MSPs increase the effectiveness of PVE approaches. Based on the baseline results, project results demonstrate that access to credit, agro-input markets, and a multi-stakeholder platform (or being in the project's intervention site) contribute to increased awareness of improved common bean varieties among farmers. In addition, farmers' attitudes towards improved common bean varieties were found to be significant in the adoption of agricultural technologies. The percentage increase in acceptance among farmers in MSP areas was significantly higher than in non-MSP areas.

### **Capacity Development:**

The main capacity-building outputs from this project included six Master of Science Degree Students in Agricultural and Applied Economics who were registered at Lilongwe University of Agriculture and Natural Resources (LUANAR). The students comprised two cohorts with two students per objective. The first cohort of three started in the first year of the project. The second cohort of three started in the second year of the project. These were four male and two female students. The research activities of these students built on each other and, in many ways, complementary across the three objectives. The first cohort of students have all completed and submitted their theses and are about to graduate, while the second cohort is finalizing the theses in readiness for external examination. Nevertheless, they have all submitted the necessary deliverables for the project. In addition to the theses as key outputs, the students have also extracted manuscripts of journal publications undergoing peer review. The students received guidance from various supervisors and institutions, including LUANAR, CIAT, Virginia Tech, and MSU Legumes Lab. The capacity building required getting ready users by equipping them with skills in digital literacy. The capacity-building package included training sessions, provision of information, and guidelines targeting users and practitioners likely to pass on knowledge to their constituencies. CADECOM field staff in addition, trained 201 farmers (females were 135). In the first roll-out series, 16 agronomists from CADECOM (4 were female) were trained in the operation and registration process of the Digital tool to be able to integrate farmers onto the platform.

**Lessons Learned:** There is a need to be adaptive to changes or constraints to achieve the targeted results, for example, after missing out on the summer season, this risked the attainment of the outputs for the year. However, with adaptation, the winter season was identified as an appropriate season to recover some of the seed multiplication by negotiating with partners. Similarly, involvement of seed companies in basic seed production was key for achievement of the outputs. The lesson learned is to be flexible and seek alternative solutions.

### **Presentations and Publications:**



Gondwe, W. (December 2022). ASSESSMENT OF MSPs EFFECT ON PRODUCTION AND SUPPLY OF CERTIFIED COMMON BEAN SEED.. Presentation at MSP Student Presentations, Lilongwe, Malawi.

Kadakoma, I., Mthakati, A., MAGRETA, R., Birachi, E. A., Larochele, C..... BREAKING BARRIERS TO ADOPTION: A MULTI-STAKEHOLDER PLATFORM APPROACH TO PROMOTING IMPROVED COMMON BEAN VARIETIES AMONG FARMERS IN MALAWI. OUTLOOK ON AGRICULTURE JOURNAL (Peer Reviewed)

Wanangwa Gondwe, M.A.R Phiri Ph.D., Eliud Birachi Ph.D., Ruth M Jambo Ph.D, Catherine, Jean Claude Rubyogo, Mercy Mutua., (2023, forthcoming). Effects of a Private-led Multi-Stakeholder Platforms on investment in certified common bean seed production in Malawi. (Submitted to Pear Reviewed Journal)

Lonjezo E. Foliás, Dr. Mthakati Alexander R. Phiri, Dr. Ruth Magreta Jambo, Dr. Eliud Birachi, Dr. Kennedy Machila, Mercy Mutua, Catherine, Dr. Wilson Nkhata, Jean Claude Rubyogo., (2023, forthcoming). Estimating Demand for Certified Bean Seed Variety among Bean-Producing Households in Dedza, Kasungu, and Mzimba Districts (Submitted to Pear Reviewed Journal)

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Kadakoma, I. (December 2022). MODELING FARMERS' AWARENESS AND CHOICE OF IMPROVED COMMON BEAN VARIETIES: Effectiveness of Multi-stakeholder Platform based Participatory Variety Evaluation Approaches in Mzimba, Dedza and Kasungu Districts. Presentation at MSP Student Presentations, Lilongwe, Malawi

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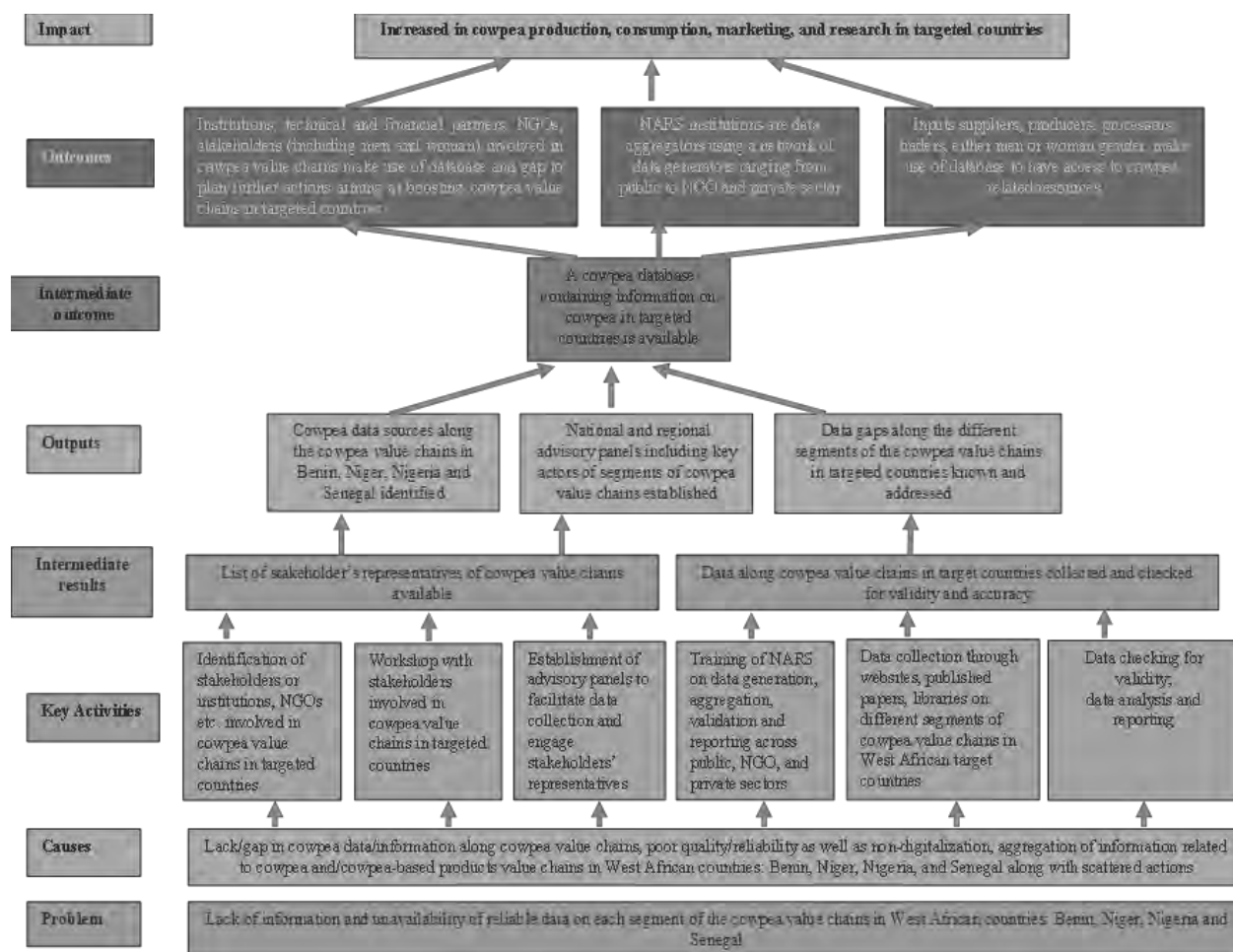
## **CA 5: Cowpea Atlas in West Africa: Mapping Cowpea Data Sources and Gaps in West Africa**

**Locations:** Benin, Nigeria, Niger, and Senegal

**Description:** Cowpea is a strategic crop for income generation and food security in West Africa and exclusively grown by smallholder farmers. Cowpea production is characterized by low yield. The crop has important potential for value addition through diversification of derived products and utilization, which is still unexploited in the sub-region. Social, cultural and economic factors hindering or promoting cowpea

production and marketing systems are poorly documented. This lack of information and unavailability of reliable data on each segment of the cowpea value chain hampers the designing of interventions to develop this value chain. As a result, stakeholders along the cowpea value chains, mainly farmers, are unable to take advantage of existing internal and export markets. In addition, there have been a number of projects and initiatives at national and regional levels, which were barely integrated and sustainable. This results in inefficient resource utilization and low investment in cowpea value chains. To tackle these challenges, this project is designed to ensure an inclusive and sustainable agricultural-led economic growth through the identification of sociocultural and/or economic motivators or barriers to cowpea utilization at various stages and scales within production and market systems in Benin, Nigeria, Niger and Senegal. More specifically, the project aims to identify cowpea data sources and gaps along the cowpea value chains in target countries. As a first step in the project implementation, a literature review will be carried out to identify key actor's groups and data sources in the various segments of the cowpea value chains in all target countries. Data will be disaggregated per gender and when relevant per relevant categories and analyzed to find the gap. Taken together, the present project aligns well with the US Global Food Security Strategy and Legume Systems Innovation Lab Objectives.

### Theory of Change and Impact Pathways(s):



**Collaborators:** Ousmane Coulibaly, Institut Sénégalais de Recherches Agricoles Regional Center of Study for the Improvement and Adaptation to Drought (CERAAS/ISRA), Senegal. Ndjido Kane, CERAAS/ISRA,

Senegal. Nicodeme Fassinou Hotegni, University of Abomey-Calavi, Benin. Nafiu Abdu, Ahmadu Bello University, Nigeria. Boka Moussa, INRAN CERRA Zinder, Niger. Dia Djiby, ISRA BAME, Senegal.

**Achievements:** In the project's first phase, advisory panels of 10 to 15 members were established to contribute to the data gap and supply data. In each country, the project and panel identified gaps in the cowpea value chain. All collected data per country were centralized in an Excel sheet ([available here](#)). Data were checked first for validity by cross checking collected data and parsing them at data manager level and Co-PI level. Parsed data were shared with the regional data manager for reporting using Google Data Studio/Looker Studio dashboard. Gaps in collected data were identified at country level and reported in an Excel sheet.

Phase 2 began with a regional workshop in Senegal in December 19-20, 2022. At the end of the meeting, it was decided that each country will have a local platform/server for data gathering. The objective of the workshop was to share an understanding of the activities to be carried out with all the implementing partners from Benin, Niger, Nigeria, and Senegal. Specifically, the objective was to define the roles and responsibilities of implementing partners including institutions in charge of agricultural statistics at the national level. Every participant came out with a clear understanding of what was expected from them. It is also important to notice the participation in the meeting of some members of the advisory panel set up during phase 1 including representatives of the National Bureau of Agricultural Statistics which will ensure the sustainability of the platform at the end of the project.

The project planned a trader preference survey preference, to design the portal of the platform, and identification of the barriers to cowpea production and consumption. However, the project concluded before these outcomes were accomplished.

**Capacity Development:** Two MSc students (both female) completed their studies in Benin at the University of Abomey Calavi. One focused on barriers to cowpea consumption in Benin, the second on barrier to cowpea production in Benin.

#### **Lessons Learned:**

- The lack of quality data is still a challenge even for better-organized commodity value chains like cotton, maize or groundnut. The poor and lack of information in all or part of segments in the cowpea value chains are a constraint to good decision making. Statistics are scarce and cannot meet the current need for analysis.
- The project's well-documented list of activities and targets helped to convince the national advisory panel members to be committed and take over the supply of data to the e-platform after the end of the project. This is an element of sustainability of the project.
- An important lesson learned from this work so far is the effective coordination between the national and the regional teams. Regular meetings and intensive communication have helped in keeping the activities on track.

#### **Presentations and Publications:**

Coulibaly, O. (February 2023) Regional initiative around cowpea value chains in West Africa for better food and nutrition security: Cowpea Atlas Project. Feed the Future Innovation Lab for Legume Systems Research - Global Convening, Livingstone, Zambia

Abdu, N. (February 2023) In Nigeria men dominate most of the cowpea value chain segments: findings from cowpea atlas data mapping and gap identification project. Feed the Future Innovation Lab for Legume Systems Research - Global Convening, Livingstone, Zambia

Godonou, Y. L. (February 2023) Revitalizing cowpea value chains in West Africa for better food and nutrition security: case of cowpea atlas platform establishment in Benin Republic. Feed the Future Innovation Lab for Legume Systems Research - Global Convening, Livingstone, Zambia

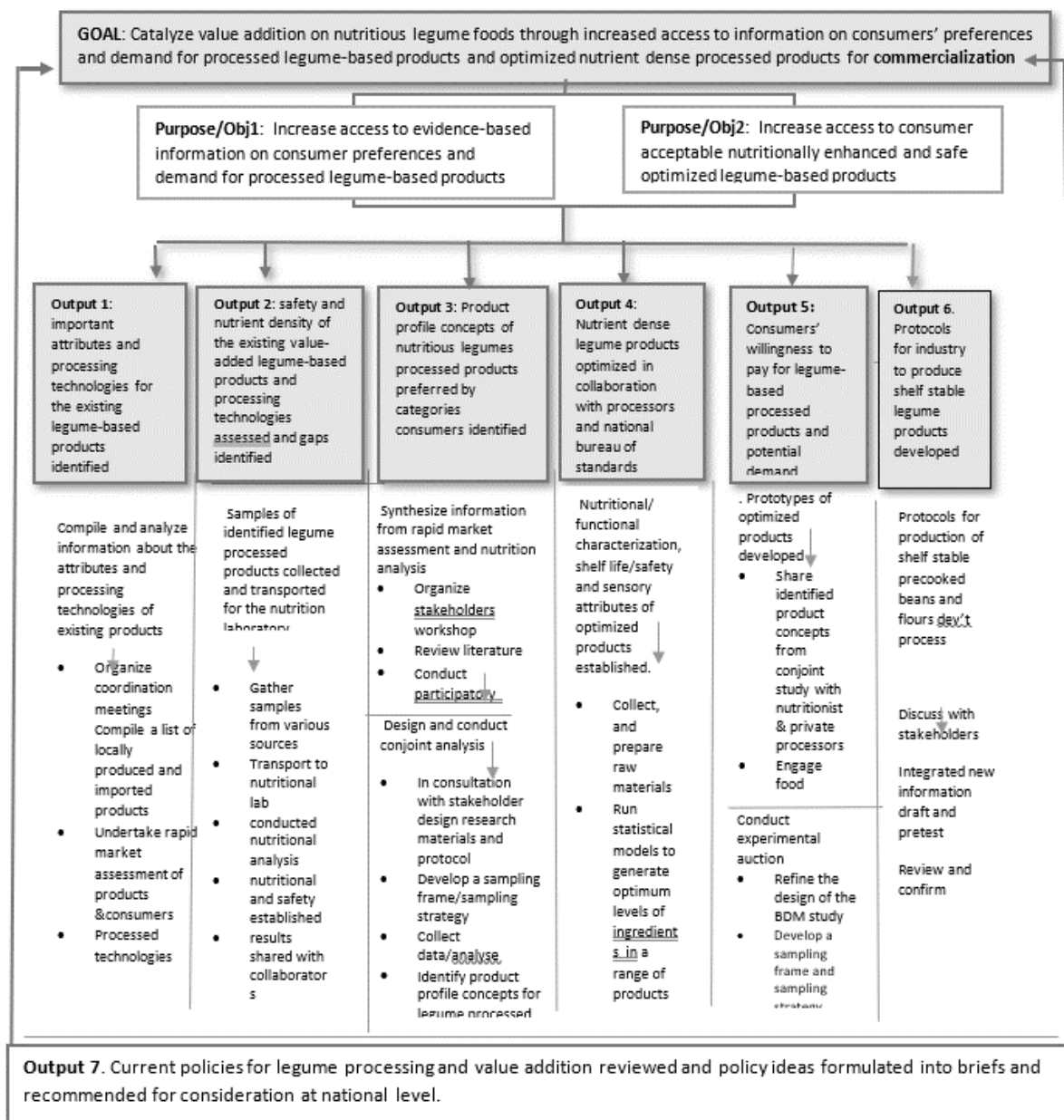
Moussa, B. (February 2023) Access to quality data for boosting cowpea value chain in Niger: the case of cowpea and cowpea products data for markets through an electronic platform. Feed the Future Innovation Lab for Legume Systems Research - Global Convening, Livingstone, Zambia

#### **CA 6: Improving Incomes and Nutrition Security Through Development and Commercialization of Consumer Preferred Processed Legume-based Products in Malawi and Zambia.**

**Locations:** Malawi (Lilongwe, Blantyre, and Karonga) Zambia (Lusaka and Mansa).

**Description:** Agro-processing in most African countries is carried out by small and medium enterprises (SMEs) hindered by unavailable quality raw materials, lack of market information, especially consumer demand, inadequate knowledge on consumer preferences, product formulation, processing and packaging, limited access to appropriate technologies to reduce food loss, wastage and nutrient leakage, and insufficient knowledge on food safety standards. However, some of these SMEs are still at the early stages of development and thus need support to expand production and meet consumer demand. The immediate support to SMEs being rendered by this project in Malawi and Zambia includes i) providing market information on the demand of value-added bean-based products, ii) testing promising value-added bean-based products and catalyzing commercialization. The legumes of focus will include common beans, cowpea, and pigeon pea.

## Theory of Change and Impact Pathways(s):



**Collaborators:** Robert Fungo, Alliance of Bioversity International and CIAT (Alliance), Uganda. Enid Katungi, Alliance, Uganda. Jean Claude Rubyogo, Alliance, Kenya. Smith Nkhata, Lilongwe University of Agricultural and Natural Resources (LUANAR), Malawi. Vincent Nyau, University of Zambia, Zambia. Virginia Chisale, DARS, Malawi. Kennedy Muimui, ZARI, Zambia. Eliud Birachi, Alliance, Rwanda. Wilson Nkhata, Alliance, Malawi. Mthakati Alexander R. Phiri, LUANAR, Malawi. Gelson Tembo, University of Zambia, Zambia. Catherine Larochelle, Virginia Tech University, USA. Mark Thompson, Trinity Super Foods, Zambia.

**Achievements:** Objective one evaluated consumer preferences & demand for legume products. The Rapid Market Assessment (RMA) revealed that most SMEs were unaware of bean-based products other than few who knew precooked beans and bean flour blends. Most SMEs indicated not having skills to add value to beans. Therefore, prototypes of precooked beans and blended bean-based flour prototypes were developed and subjected to willingness to pay studies. The choice experiment revealed that legume blended flour with 70% maize, 10% common bean 15% soya bean and 5% groundnut was the most preferred. The willingness to pay studies revealed that consumers were willing to pay a higher price for processed bean products. Consumers' (75% in Malawi and 74% in Zambia) were willing to pay for dehydrated pre-cooked beans an equal or greater than the selling market price. Experimental auction studies revealed that consumers, if provided with product information would pay 16% (convenience) and 11% (nutritional value) for the product, more than market value for pre-cooked beans. Objective two aimed at increasing access to knowledge on the consumer preferences and demand for value-added products. Informed by RMA results, a total of 14 bean-based prototypes with potential for commercialization were developed and optimized. Acceptability results revealed that all prototypes had above average mean scores suggesting they have potential for commercialization. Bean flour blends and precooked beans the most preferred prototypes, were optimized. Porridges produced by optimized bean blended flours were not significantly different ( $p = 0.2644$ ) from soy-maize blend porridges. Thus bean blends have similar acceptability as soy-maize blend. Precooked beans were optimized for pre-cooking treatments and effect on color, taste aroma and cooking time. Optimized precooked beans were preferred because of their convenience, short cooking time, saving energy and labor. Policy briefs and processing protocols for products were produced.

**Capacity Development:** Overall this year, Institutional capacity development efforts to mainstream gender in the processing plants were initiated. Also, issues regarding safety and hygiene in processing plants of processors were addressed by conducting several HACPP/GMPs in both Malawi and Zambia. To accompany these efforts, we also produced and distributed processing protocols for precooked beans and bean flour blends. Policies were also reviewed and policy briefs for both Malawi and Zambia were produced. We have continued to run a digital platform (WhatsApp group) where exchanges of ideas and plans on how to support private food processors to integrate legumes in their products or add value to legumes, especially beans are discussed. Information shared on this platform include training and funding opportunities to processors, marketing information and linkages, exchange of ideas, motivations talks, as well as consultations that go beyond the WhatsApp group and encourage institutional interactions.

Under objective 1, two MSc students (1 female) from LUANAR in Malawi; and one female MSc student from UNZA Zambia have collected data and prepared draft theses. The UNZA student has since submitted her thesis for examination pending graduation. The students in Malawi will be submitting their theses for examination. Under short-term training, 4 students learned choice experiment design, experimental auction, sample size determination, sampling and questionnaire development • The students were also guided and coached in presentation skills during global convening meeting held in Livingstone. We noticed that good presentation skills require practice and requested LUANAR to expose the students to more opportunities for learning how to present key message within time provided.

Under objective 2, the project also continued supporting three MSc Human Nutrition students (two female) in Malawi. The male students has since submitted his thesis for examination. The female students are preparing their theses and will be submitting by end of November. A number of publications are also being prepared. In terms of capacity development, there have been virtual and physical interactions with the students to mentor, coach and supervise them. During finalization of their theses; during the global convening preparations; and during preparations for experimental auction and optimization activities the students have been exposed to new knowledge and skills. The professors, as well as Alliance-PABRA staff have continuously supervised the project and guide them to analyze their data and write their theses, abstracts and presentations and scientifically guide them to align with the project needs. In such nature, the capacity of the students have also been shaped tremendously.



**Lessons Learned:** Bean-based prototypes are highly acceptable, nutritionally good and can cost effectively be produced, implying potential for commercialization. There is need to promote production of beans because we have learnt that they are expensive for some MSMEs due to short supply-chain. There is a need to promote locally produced beans and legumes among processors. Create demand for beans in relief programs. Gender imbalances are prevalent in the processing sector and should be mainstreamed in the sector. Intellectual properties issues need to be well defined to processors. There is a need to define areas of conflict and address them at early stage of the relationship. Monitoring and evaluation initiatives are instrumental in achievements of project milestones and map project continuity and sustainability possibilities. There is synergy in value chain approach. It is cultivated from working and bringing different components of the value chain together. There is need to promote strategic linkages of the businesses to other opportunities, especially partners who can offer a service one cannot.

#### **Presentations and Publications:**

Fungo, R. (October 2022). Updates of Food Processing Project. Presentation at ZAMBIA USAID MISSION Food Processing Project Updates, Online

## **VI. Associate Award and Mission Buy-In Projects**

### **Feed the Future SAWBO Responsive Adaptive Participatory Information Dissemination (RAPID) Scaling Program Associate Award (Cooperative Agreement No. 7200AA20LA00002)**

**Project Description:** Scientific Animations Without Borders (SAWBO) has a decade of experience in producing over 150 educational animations in over 280 languages and accent variants for tens of millions of viewers across the globe. This experience positioned SAWBO well to respond to USAID's request for projects to address the secondary effects of COVID-19 on agriculture and food security. The Scientific Animations without Borders (SAWBO) Responsive, Adaptive, Participatory Information Dissemination (RAPID) scaling program serves as an educational intervention effort to disseminate crucial information related to COVID-19's secondary economic impacts, including disruption to trade, supply chains and markets.

The purpose of SAWBO *RAPID* was to ensure that important COVID-19 information be delivered across borders, cultures, and literacy levels by quickly developing educational animations in local languages and using virtual dissemination platforms to reach remote and marginalized communities. The program also built on SAWBO's research-to-impact approach. This approach, with over 33 publications addressing research questions necessary to provide an evidentiary base to SAWBO strategies is cutting-edge, allowing land grant institutions to translate research outcomes into powerful global impacts, even in a COVID-19 world. Prior to SAWBO *RAPID*, the SAWBO program had created over 150 animated topics in over 280 language and accent variants. SAWBO videos can currently be found on TV stations in both West and East Africa, with over 60 million people known to have benefited from them. Likewise, SAWBO *RAPID*'s COVID-19 response sets the groundwork for a systems approach for educational responses to future global catastrophes and further democratizes information critical to surviving these critical historical turning points. Like SAWBO, SAWBO *RAPID*'s content, once created, is immediately available for anyone or any group to use for educational purposes in any way that fits their needs – circumventing costly delays and the great inequalities of information that would occur if less developed part of the world were left to create their own responses to crises. The SAWBO system is focused on providing accurate educational information for people of all literacy levels across and as many language groups as possible – content that can be used by other individuals and groups around the world to have impact in their community in real time – allowing for a RAPID response to emerging challenges.

**Where Project Works:** The project worked in Bangladesh, Ghana, Kenya, and Nigeria.



**Collaborators:** Barry Pittendrigh, Purdue University, USA. John Medendorp, Purdue University, USA. Julia Bello-Bravo, Purdue University, USA.

**Achievements:** Concluded December 31, 2021, the SAWBO *RAPID* scaling program implemented activities of video animation selection, production, dissemination, and research. Over these four phases of the SAWBO-*RAPID* scaling program, the team:

Worked with Missions and Innovation Labs to identify key behavioral changes necessary to mitigate the secondary economic effects of the COVID-19 pandemic crises.

Produced ten animated videos (with five extra cultural variants) for immediate and permanent distribution for use by individuals and/or groups in the target countries of Bangladesh, Ghana, Kenya, and Nigeria, and across the globe. One animation (jerrican storage of beans/grains) was placed in over 100 language variants for Ghana, Kenya, and Nigeria.

Disseminated the critical information available in the animated videos to over 20 million persons in four target countries with a two-tiered dissemination strategy consisting of funded pushes through available social media platforms and television as well as collaborative pushes through existing networks consisting of Government Organizations (GOs) Non-government Organizations (NGOs), and social media networks (SMNs).

Did significant research through baseline and penetration studies on the reach and use of the videos as well as the adoption of the techniques explained in the videos.

Refined our understanding of information dissemination in the four target countries and provided the Missions with information dissemination strategies.

For more information about the SAWBO *RAPID* program, please see [final technical report](#).<sup>3</sup>

## USAID/South Sudan Buy-In

**Project Description:** This project concluded in FY2022 and was a buy-in to provide continuing support to 15 South Sudanese students pursuing graduate degrees (MSc or PhD) in the agricultural sciences under the Borlaug Higher Education for Agricultural Research and Development (BHEARD) program. The purpose of this activity is to lend support and oversight for degree completion to students in the agricultural sciences at their respective higher education institutions in Kenya. Support includes advocacy for students to their respective institutions and monitoring of progress to degree, as well as financial support for tuition, living accommodations during their time in Kenya, and, in some limited cases, return passage between South Sudan and Kenya. This buy-in occurred in September 2020. For further information about this activity and support of the 15 South Sudanese students prior to September 2020, please refer to the Borlaug Higher Education for Agricultural Research and Development (BHEARD) website at <https://www.canr.msu.edu/bheard/>.

The BHEARD program, supported by USAID, develops agricultural scientists and increases agricultural research capacity in Feed the Future partner countries, including South Sudan. BHEARD provides scholarships to students seeking Master's and Doctorate degrees at U.S. and regional academic institutions and provides funding for agricultural research in their home countries. The program also develops, tests, and evaluates new models of small-scale institutional capacity development.

**Collaborators:** Dr. George Barack Otieno, BHEARD Regional Coordinator, Kenya.

**Achievements:** Of the 15 South Sudanese students pursuing graduate degrees in agriculture sciences, twelve scholars have completed their degrees and three students' studies ended without graduating. A group of nine crop and animal scientists trained under the BHEARD program founded the Initiative for Livestock and Agricultural Development (ILAD). The team has established two demonstration plots around the city of Juba and trained 122 farmers to adopt good agronomic practices through appropriate technology transfer modalities and practices. The team trained identified community facilitators (lead farmers), trained farmers on crop production techniques such as micro-irrigation, soil-water management, integrated pest management, seed production, and provided training on dry season vegetable production, water conservation and management. Planned activities in the next quarter include training farmers on small-scale poultry production including feeding practices, housing, disease prevention and control practices, and behavior management of birds. Additionally, the team will conduct outreach visits to peri-urban cattle camps to enlighten cattle keepers about the economic value of cattle and cattle products (milk, hides), disease prevention and control practices, meat and milk hygiene practices, and public health education (zoonotic diseases).

**Capacity Development:** As mentioned above, 122 farmers were trained in good agronomic practices. The team also trained lead farmers to facilitate ongoing training the lead farmers' community. The programs of study of the 15 students from South Sudan are Livestock Production Systems, Plant Pathology, Agronomy, Animal Science, Agricultural Economics, Horticulture, Veterinary Epidemiology & Economics, Agricultural Entomology, Animal Production, and Land and Water Management.

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<sup>3</sup> Final technical report available on USAID's Development Experience Clearinghouse at: [https://dec.usaid.gov/dec/content/Detail\\_Presto.aspx?vID=47&ctID=ODVhZjk4NWQtM2YyMi00YjRmLTkxNjktZTcxMjM2NDZmY2Uy&rID=NjA2MzAz](https://dec.usaid.gov/dec/content/Detail_Presto.aspx?vID=47&ctID=ODVhZjk4NWQtM2YyMi00YjRmLTkxNjktZTcxMjM2NDZmY2Uy&rID=NjA2MzAz)

**Lessons Learned:** The project recommends supporting local farmers with transport (such as tricycles) for transporting produce to market. The tricycle should be under the care of the group leader so that farmers can pool their produce to be transported to the market.

## USAID/Niger Buy-In “Improving Cowpea Production in Niger *Améliorer la production de niébé au Niger*”

**Project Description:** In response to the USAID Niger Mission’s request the ME of the Legume Systems Innovation Lab is implementing two activities—(a) Integrated Pest Management (IPM) Solutions and (b) Improved Varieties of Cowpea as priority areas.

### **Integrated Pest Management (IPM) Solutions**

Over the past decade, INRAN, University of Maradi, IITA, and Scientific Animations Without Borders (SAWBO; based at Purdue University and associated with the Legume Systems Innovation Lab) have created and tested the use of animations (in local languages in Niger) to train farmers on better strategies for controlling insect pests without the need for second-generation chemical pesticide sprays. These animations have been shown to be effective tools for educating farmers. Videos can be easily shared with other private and public sector entities who can use these in their educational programs. These actors (individuals deploying content and building networks are hereafter called “actors”) and entities can be trained on how to impact farmers, regardless of the farmers’ access to video capable cell phones. The next step is to both scale and to train other private and public sector actors in the use and scaling of the educational animated content in Niger. Thus, this project seeks a pan-Niger network for the deployment of such educational content scaling with farmers in Niger. In this program the team will focus on enabling online and offline networks towards scaling, coupled with engaging traditional media outlets in Niger.

It is important to note that the main focus of this program will be to use these tools towards development of capacity on a broad scale that will result in a systems approach to a pan-Niger deployment network that can be used to continually scale other content beyond the scope of this specific project. This systems approach includes using existing networks to disseminate material and developing capacity to maintain information dissemination maps at the national level (preferably within the NARES), working with organizations to seek and use existing animated materials, and working with extension systems to train extension agents to understand and utilize the animation in on-line and off-line format.

### **Improved Varieties of Cowpea**

Cowpea seed used by farmers in Niger comes from both informal (farmer saved) and formal (NARS, CGIAR and the private sector) seed systems. However, in 2018-2020, certified seed supplied by the Nigerien formal sector only accounted for 0.5 to 1.5% of the seed needed or used by Nigerien farmers (FAOSTAT). Clearly, there is a significant shortfall in quality seed coming from formal seed channels. In Niger, the lead public sector cowpea breeding institution is The Niger National Institute of Agricultural Research (INRAN), Niger’s principal (cowpea) agricultural research agency. INRAN has strong connections with the International Institute of Tropical Agriculture (IITA), which has a long history of developing cowpea varieties for use by the NARS using advanced breeding techniques. This project will develop a cowpea variety process map based on the cowpea variety product life cycle with a main focus on identifying varieties carrying the key traits outlined by the Niger USAID Mission for scaling over the next three years.

It is important to note that it is highly unlikely that any one variety would carry all of the desired traits requested by the Mission. Choices have to be made to address stakeholder needs. In some instances, e.g., pod borer resistance, there are no known resistance factors within the cowpea gene pool.

**Collaborators:** Joseph Huesing, Huesing Ag Ed, USA. Scientific Animations Without Borders (SAWBO). Amadou Laouali, L'Institut National de la Recherche Agronomique du Niger (INRAN), Niger. Ibrahim Baoua, Universite de Maradi, Ousmane Boukar, IITA, Nigeria.

**Achievements:** The project has completed a final report under the improved cowpea varieties what will be shared on the project website (<https://www.canr.msu.edu/resources/improving-cowpea-production-in-niger>). The project found that despite decades of investment by USAID in INRAN breeding operations, as well as at the CGIAR, notably IITA, improvements in INRAN breeding operations still lag behind those of the private sector. For example, INRAN does not currently use a product life cycle approach to varietal development. Implementation of modern breeding efforts is a major goal of the IITA breeding program which supports INRAN and other West African NARS. IITA is currently implementing a PLC process internally and is also making this training available to the NARS including INRAN. Accordingly, it is hoped that the PLC approach is adopted at INRAN soon. As the PLC approach is new to much of USAID programming this lag in adoption of the approach by INRAN is not unexpected. Furthermore, there appears to be little alignment between identification of key stakeholder traits and their selection within the INRAN breeding program. This too is not surprising since the use of a Multi-Stakeholder Platform approach (MSP), championed by the Legume Lab, is also new to USAID programming. A strong recommendation for a Phase II of this project would be implementation of an MSP/PLC program to improve cowpea breeding at INRAN.

Under the IPM portion of the project a training workshop on the use of SAWBO videos was conducted in July, 2023, with representation by 13 organizations who manage a total of 120 WhatsApp groups and a total of 24,850 members. A total of six videos were adapted to the Nigerien context and then translated into French, Hausa, Kanura, and Zarma. The videos can be found at: <https://nigercowpeaipm.sawbo-animations.org/>. At the same time, a WhatsApp group was established representing 196 farmer groups and over 59,000 farmers. The WhatsApp group is currently active, discussing daily topics related to cowpea production.

A baseline study was conducted to attempt to discern the levels of awareness of the SAWBO IPM videos before the distribution of the videos in order to determine the effectiveness of the distribution among the farm groups in Niger. The baseline study worked with two different groups. The control group consisted of farmer groups that will not be intentionally target for distribution of the IPM videos. The experimental groups will be intentionally targeted for video distribution. The use of two groups will allow us to see 1) how effective video distribution has been among those groups that are intentionally targeted for distribution and 2) how effective distribution has been to non-targeted groups using social media and other NGOs to carry out the distribution. The baseline study was completed in September and showed that very low percentages of both the control and the experimental populations had already seen the SAWBO videos (See Tables Niger-1 and Niger-2). The prospects for increased awareness and effectiveness of distribution systems are very high. The one remaining question to be answered will be the comparative effectiveness of the two distribution systems: 1) social media, television, NGOs as compared to 2) social media, television, NGOs, WhatsApp groups, targeted interventions.

**Table Niger-1: Proportion of respondents by SAWBO videos viewed and by region**

	Maradi	Tahoua	Zinder	Average	$\chi^2$	P-value
Neem seed juice	1.7	0	1.1	0.9	5.51	0.06
Neem tea bag	1.7	0	0	0.6	11.86	0.003
Cowpea storage in airtight containers	1.1	0	0	0.4	7.89	0.01



Solarization of cowpea seeds	0.3	0	0	0.1	1.96	0.37
Using the PICS bag	1.9	0	0	0.6	13.85	<0.001
Integrated control of the cowpea pod borer	1.7	0	0	0.6	11.86	0.003
None	96.1	100	99.2	98.4	19.09	<0.001

**Table 2: Proportion of respondents by SAWBO videos viewed and by type of village**

	Control villages	Villages of intervention	%Average	$\chi^2$	P-value
Neem seed juice	0	1.4	0.9	5.09	0.24
Neem tea bag	0	0.8	0.6	3.04	0.08
Cowpea storage in airtight containers	0	0.6	0.4	2.02	0.15
Solarization of cowpea seeds	0	0.1	0.1	0.5	0.47
Using the PICS bag	0	1	0.6	3.55	0.06
Integrated control of the cowpea pod borer	0	0.8	0.6	3.04	0.08
None	100	97.6	98.4	8.7	0.003

**Capacity Development:** Translators were trained to use program software for the local language variations of the SAWBO videos.

**Lessons Learned:** Begin the UEI process long in advance of contracting with potential institutional collaborators.

## USAID/Nepal Buy-In

**Project Description:** In response to a request from the USAID Mission in Nepal, the Legume Systems Innovation Lab implemented the project, “Transforming the Lentil Sector in Nepal.” Lentil is an important crop in Nepal for nutrition, soil health, and as both a staple and export commodity. However, crop yields have become stagnant with the low productivity attributed mainly to stressed environmental conditions and agronomic practices. Lentil products compete with imports as large legume processors prefer imported lentil due to cost and uniformity. Lentils occupy 60% of the total grain legume area and production in Nepal, making the country the sixth largest producer and fifth largest exporter of lentils. Given that lentil demand has expanded

6.2% over the past ten years, it is estimated that Nepal's revenue from lentil export could double or even triple if relevant actions are taken to boost cultivated area, productivity, and market integration.

Nepal lentil is among the most nutrient dense in the world however many of these nutritionally rich varieties do not possess the stress and disease tolerant traits for higher yield potentials. Research indicates that the average age of commercialized lentil varieties is 27 years and that 85% of small holder farmers use seed that is decades old. One goal of the project is to identify varieties that are stress resistant, nutritionally biofortified, high yielding, and consumer preferred and provide strategies for farmer variety adoption.

The project will also identify low-cost, low-barrier easily adjustable farming practice solutions and deployment strategies that are expected to lead to increased yields, decreased pest and disease damage, and reduction of post-harvest loss. The solutions will be delivered through a "curriculum" for lentil farming developed in conjunction with national agricultural extension agencies. These best practices will be deconstructed into easy-to-follow steps and visualized in animations created by Scientific Animations Without Borders (SAWBO). SAWBO is a Purdue university-based program that transforms extension information into 2D, 2.5D and 3D animations, which are then voice overlaid into a diversity of Nepalese languages.

A closer look into the Nepal lentil seed and market systems will also identify bottlenecks and weak points from seed/variety availability from the producer level all the way through to legume market and export. A special focus will be made on the variety nutritional panels and potential advantage for nutrition fortified varieties.

To address these issues the project will organize two or three multi-stakeholder platforms (MSP). MSPs provide "spaces" for learning and knowledge exchange where various stakeholders come together to diagnose their challenges and identify opportunities to address them that are mutually benefiting. The project will build upon existing networks to organize the MSPs.

**Collaborators:** Joseph Huesing, Huesing Ag Ed, USA. Dhruva Thapa, Rojan Karki, Namita Nepal, Sony KC, Yamuna Ghale, Nepal Agricultural Research Council (NARC), Eliud Birachi, Alliance Bioversity and CIAT (Alliance), and Radegunda Kessy, Alliance

**Achievements: Multi-stakeholder platforms** - In April 2023, the USAID Lentil Strengthening Activity established Multi-Stakeholder Platforms (MSPs) in the three provinces that produce more than 90 percent of Nepal's lentils: Sudurpaschim, Lumbini, and Madhesh. In each province, the MSPs formed an interim committee to establish an initial strategic action plan and a list of potential participants. At a subsequent MSP meeting which took place in Nepalgunj in July, the three interim committees provided an update on their activities to date. Sudurpaschim and Madhesh Pradesh provinces had not advanced much since their inception in April. Although they developed action plans and representative lists for their respective MSPs, the members had not convened. The interim MSP committee in Lumbini Province also developed their strategic action plan and list of potential representatives, and went on to contact the representatives, organize a meeting, and validate their action plan. Following presentation of the plan to provincial government officials, the Lumbini MSP secured funding from the provincial government, along with a set-aside of 600 hectares for lentil grain production and 100 hectares for lentil seed production. At the July event, the interim committee of the Lumbini MSP evolved into a formal steering committee. Their next steps include determining the leadership members and structure, the roles and responsibilities of MSP representatives, and a sustainable financing model.

**Seed system study** - At the July MSP meeting in Nepalgunj, Lumbini Province, Dr. Dhruva Thapa and his team presented the findings of an exhaustive study on the lentil seed system. The study identified several deficiencies in the lentil value chain, which will be included in a final technical report. Recommendations from the study included:



- Increased demand for lentils in the domestic and international market. This demand provides opportunities for increased lentil seed production, leading to higher incomes for farmers.
- Availability of some released varieties, crossing materials and pipeline varieties for commercialization. These materials could play vital roles in increased adoption of improved lentil varieties with higher yields, disease resistance, and stress tolerance and enhance the productivity and profitability of the lentil seed production system. These varieties can also help address the challenges posed by pests, diseases, and changing climatic conditions.
- Supportive policies, subsidies, and extension services provided by the government can encourage farmers to engage in lentil seed production. Investments in infrastructure, irrigation facilities, and capacity-building programs can further strengthen the lentil seed production system. The government has focused on the following programs to support lentil:
  - Research and Development: Assess the potential of lentil production in Nepal, including suitable regions, climatic conditions, and varieties. Strengthen collaboration with agricultural research institutions and experts to identify best practices for lentil cultivation and post-harvest management.
  - Farmers training and advisory services: Organize training programs and workshops for farmers to enhance their knowledge and skills in lentil cultivation techniques, such as seed selection, land preparation, planting, irrigation, pest and disease management, and harvesting. Provide practical demonstrations and hands-on training to ensure effective adoption of recommended practices.
  - Seed availability and distribution: Ensure the availability of quality lentil seeds to farmers. Establish seed production and multiplication programs to meet the demand. Collaborate with seed companies, cooperatives, and agricultural institutions to produce certified seeds and distribute them through government channels, including agriculture extension offices and cooperatives.
  - Financial support and incentives: Provide financial support to farmers through subsidies, grants, and loans to encourage lentil cultivation. Offer incentives such as insurance coverage, and access to credit facilities for lentil farmers. This will help reduce financial barriers and promote widespread adoption of lentil cultivation.
  - Infrastructure development: Invest in the development of necessary infrastructure to support lentil production, including irrigation systems, storage facilities, processing units, and market linkages. Improve access to rural roads to facilitate the transportation of lentil produce from farms to markets.
  - Market development and value addition: Facilitate market linkages for lentil farmers by establishing partnerships with traders, wholesalers, and retailers. Promote value addition through processing and packaging to enhance the market value of lentil products. Encourage the establishment of lentil-based agro-industries, such as lentil flour mills, to diversify product offerings and create additional revenue streams.
  - Awareness and marketing campaigns: Conduct awareness campaigns to educate consumers about the nutritional benefits of lentils and promote their consumption. Use various media channels, including television, radio, social media, and print media, to disseminate information about lentil production, recipes, and health benefits. Participate in trade fairs, exhibitions, and agricultural events to showcase lentil products and create market demand.
  - Monitoring and evaluation: Establish a monitoring and evaluation system to assess the progress and impact of lentil promotion programs. Regularly collect data on lentil production, area under cultivation, yields, market prices, and farmer incomes. Analyze the data to identify challenges and opportunities and make necessary adjustments to the program implementation strategies.
  - Policy Support: Advocate for policy reforms and supportive measures that prioritize lentil production and marketing. Work closely with government agencies, policymakers, and relevant stakeholders to create an enabling environment for lentil cultivation, including favorable trade policies, research funding, and infrastructure development.

**Baseline study of good agricultural practices (GAPs)** -An exhaustive study of the current practices employed by farmers for lentil seed and grain production in Nepal served as a baseline for the ex-post study

on the distribution of training materials on good agricultural practices for lentil production. The study found that only 20% of lentil farmers surveyed had received any training in good agricultural practices for lentil production. In addition, of those who had received training, 80% of the training had been provided by a cooperative. Further, very few farmers invest in inputs for lentil production, and seed is usually provided at low cost by the municipality. The quality of that seed is low and the varieties are mixed, leading to uneven maturity, varied grain size, quality, and even color. Seed is broadcast. Tillers are minimally used for initial plot preparation. Little time or labor is invested in weeding, herbicide applications, pest management, irrigation, fertilizer use, harvesters, or threshers. Some farmers noted that they broadcast their seed during the planting phase, but do not return until harvest. Harvest is typically by hand. Where harvesters are used, they usually are adapted multipurpose machinery used for lentil harvesting but with significant loss and damage. Threshing is typically done by hand. Where threshers are used, the quality of the on-farm processing is low. A lack of knowledge and implementation of good agricultural practices explains why farmers' average yields are between 600-700 kg/ha and the quality of the processed grain is low. Significant gains in yield and quality could be had if GAPs were widely taught and widely practiced.

**Market System Study** - Findings from an exhaustive study on domestic lentil markets that included information on buyers, sellers, preferred grain types, cross border trade with India, and consumer preferences for lentil discovered that the key problems affecting lentil markets were:

- Many lentil processing units in Nepal still rely on traditional, manual methods that are time-consuming and less efficient. The absence of modern processing technologies, such as mechanized cleaning, grading, and milling equipment, hampers the overall productivity and quality of lentil processing.
- Many small-scale lentil processors in Nepal face challenges in accessing credit and finance for investing in modern processing equipment and infrastructure. This limits their ability to upgrade their processing facilities and adopt efficient processing practices.
- There is a lack of standardized quality parameters and grading systems for lentils in Nepal. This can lead to variations in product quality, making it difficult to establish a consistent market reputation and meet the requirements of domestic and international buyers.

Among the underlying causes of these issues, the study revealed that:

- Insufficient investment from both the Nepal government and the private sector has contributed to the inadequate development of the lentil processing sector. Consequently, there is a dearth of quality processing facilities and limited market access for Nepali lentil processors.
- Nepal has limited infrastructure, such as roads and ports. This makes transporting lentils from production areas to processing facilities and exporting them to international markets difficult and expensive. Nepal has a road density of only 0.6 kilometers per square kilometer, one of the world's lowest (International Labor Organization, 2009).
- The lentil industry is operating at 50% of its capacity, indicating underutilization of resources. The Terai lentil marketing network is complex and costly, involving multiple intermediaries, resulting in inefficiencies and increased expenses (IFPRI, 2019).

Relevant system functions are:

- Simplifying the marketing network and reducing the involvement of intermediaries can help minimize inefficiencies and costs. The government can support the establishment of direct marketing channels, such as farmers' cooperatives or producer groups, to enable direct access to buyers. Promoting transparent and fair-trade practices will enhance trust and dialogue within the supply chain.

- Engaging neighboring countries, especially India, in discussions and agreements on lentil trade can help address cross-border challenges and promote formal trade channels. Collaborative efforts can focus on establishing standardized quality parameters, facilitating trade facilitation measures, and promoting regional cooperation in the lentil sector.
- Investment in research and development can lead to improving lentil varieties, pest management techniques, and processing technologies tailored to the local context. Collaboration between research institutions, universities, and the private sector can drive innovation and address specific challenges faced by the lentil industry in Nepal.

Challenges at the system level were:

- Lentil processing sector in Nepal suffers from fragmentation and a lack of coordination. This situation can result in redundant efforts, missed opportunities, and a lack of overall progress.
- Lentil is considered an orphan crop with limited research and investment compared to major staple crops. One significant consequence of this neglect is the absence of specialized mechanization for lentil cultivation. Addressing this issue through targeted research and investment could enhance productivity and contribute to sustainable agriculture.

Opportunities, on the other hand were:

- Nepal is exploring new markets for its lentils. In 2022, Nepal exported lentils to 20 countries, including China, the Middle East, and the United States (Nepal Trade Portal, 2022). The Nepal government can continue to explore new markets to increase lentil exports.
- In recent years, the Nepal government has increased investment in the lentil sector, yielding positive outcomes in terms of quality and productivity. The government can sustain its investment in the lentil sector to further enhance these improvements..
- A multi-stakeholder platform allows lentil processors to collaborate, share knowledge, and learn from diverse stakeholders, including government agencies, research institutions, and farmers' cooperatives. Outcomes of this engagement include improved processing techniques, quality standards, and market access through the exchange of expertise and best practices.

The study made the following recommendations for enhancing lentil markets in Nepal: •

- Intervention 1: Promotion of improved varieties of lentils that give higher yields and ensure availability of adequate amounts of improved seeds to farmers. Potential partners: NARC, Agrovets, IFPRI
- Intervention 2: Improving access to irrigation facilities. Potential partners: Local government
- Intervention 3: Improve the system of lentil aggregation and milling along with quality grading. Potential partners: Mills, cooperatives, aggregators
- Intervention 4: Develop a fair system for lentil exports. Potential partners: TEPC, Ministry of Commerce and Industry, Ministry of Agriculture and Livestock Development.
- Intervention 5: Implement effective regulations and record keeping for informal trade. Potential partners: Ministry of Finance, Ministry of Home Affairs, Ministry of Agriculture and Livestock Development.
- Intervention 6: Facilitate connections between farmers and buyers to ensure a steady demand for lentils and reduce the risk of surplus production going to waste. Potential partners: Ministry of Agriculture and Livestock Development, TEPC, Aggregators.
- Intervention 7: Provide farmers with post-harvest training and invest in suitable storage facilities. Potential partners: Local government, Provincial government, and Co-operatives.

- Intervention 8: Establish research and extension programs to disseminate best agricultural practices and provide technical support to farmers in lentil production. Potential partners: NARC, MoALD, NGOs.
- Intervention 9: Promote sustainable agricultural practices to improve soil fertility and reduce reliance on chemical inputs. Potential partners: MoALD, NGOs, and Farmer Groups.
- Intervention 10: Enhance access to credit and financial services for smallholder lentil farmers to invest in modern farming technologies and inputs. Potential partners: Agricultural banks, microfinance institutions, and Agricultural credit programs.
- Intervention 11: Conduct market intelligence and price forecasting to enable farmers to make informed decisions on timing their lentil sales for better profitability. Potential partners: Agricultural market research agencies MoALD.
- Intervention 12: Establish market linkages and value chains for lentil-based products in domestic and international markets. Potential partners: Exporters, retailers, food processing industries, trade promotion bodies.
- Intervention 13: Encourage public-private partnerships for investing in lentil processing and value-addition infrastructure to increase product diversity and export potential. Potential partners: Private sector companies, government agencies, NGOs.
- Intervention 14: Create awareness campaigns and consumer education programs to promote the nutritional benefits of lentils and increase domestic demand through PSAs and SAWBO videos. Potential partners: Ministry of Health and Population, NGOs, media outlets. •
- Intervention 15 : Establish Gender-Inclusive Agricultural Training Programs. Potential partners: MoALD, NGOs, Private Sectors, Academic Institutions, International Development Agencies and Farmer Groups.

These findings will be described in detail in the final technical report which will be submitted to the mission in a separate document.

**Lentil varietal mapping and varietal development strategy** -An exhaustive study of global lentil varieties, their traits, and potential application in the lentil production systems of Nepal. In addition, this study makes recommendations for the design of comparison trials which will be carried out in stages. These efforts will conclude with a long term varietal development strategy and directions for a national breeding program that will capture desirable traits from promising global varieties and cross them into Nepalese varieties in order to develop varieties that will have the resistances and tolerances necessary to make the Nepali lentil production sector resilient to systems shocks, especially those caused by changes in climate that currently make lentil production a high-risk endeavor.

**Lentil production video library** - Fifteen educational animations that encompass the entire growing season for lentils from pre planting to post harvest and address the following issues:

- Varietal selection
- Seed and soil preparation
- Fertilizer use
- Planting
- Integrated pest management (IPM)
- Irrigation and drainage
- Harvesting
- Storage
- Micro-financing

Each of the videos has been translated into English, Nepali, and seven other Nepali languages and dialects. Several of the videos were pushed on social media (YouTube) that resulted in over 7 million views in Nepal. The content was also placed on several TV stations throughout the country that have programming oriented to rural populations with an estimated viewership of 15 million people.

**Capacity Development:** Over 90 individuals trained in MSP formation and mentored by MSP experts from Alliance Bioversity and CIAT. One SAWBO video on properly storing dried grains and legumes including lentils using hermetically sealed bags released June 2023, has over 120,000. The impact of these videos will be captured after harvest.

**Lessons Learned:** The power of convening private sector and government actors in a room under the MSP training and promotion highlighted how stakeholders for different backgrounds can forge alliances to address shared challenges.

## VII. Human and Institutional Capacity Development

### A. Short-term Training

Table 2: Short-term Training

Country of Training	Brief Purpose of Training	Who was Trained	Number Trained		
			M	F	Total
Benin – AOI 1.2	Lab and screenhouse trials to investigate host finding behavior of pod borer parasitoids <i>Liragathis javana</i>	People in Civil Society,	0	1	1
Niger – AOI 1.2	Validate the operational version of the Farmer Interface App FIA niebe for scouting the cowpea pod bug <i>Clavigralla tomentosicollis</i> in farmers fields.	People in Government, People in Civil Society, Producer: Smallholder farmers,	48	22	70
Niger AOI 1.2	To sensitize farmers about the risk of chemical pesticide and the beneficial effect of using alternative methods such as biopesticides made of neem tea bags	Producer: Smallholder farmers,	1184	821	2005
United States AOI 2.2	One semester of non-degree training for two advanced PhD candidates from Nigeria to observed research and writing process of colleagues and mentors over the course of one semester. When the visiting scholars return to Nigeria, they conducted training sessions for junior researchers at each of their universities.	Type of individual not available,	2	0	2
Malawi – CA4	The training was aimed at building the capacity of project facilitators to promote gender equality in the project activities and in the multistakeholder platforms.	People in Government, Civil Society, and farmer	25	21	46

Country of Training	Brief Purpose of Training	Who was Trained	Number Trained		
			M	F	Total
Malawi – CA4	Identification of bean diseases and pests, good production practices, managing for rain-fed production, and post-harvest management. It was designed to equip field extension with skills that they can pass on to the producers.	People in Government, Producer: Smallholder farmers,	272	370	642
Malawi – CA6	The training was an interactive learning aimed at sharing knowledge on how to design conjoint based studies and enhance the skills of partners to lead the empirical design and implementation of the studies using the approach adopted under the project. Students gained skills on technical concepts relevant for their thesis research	People in Government,	7	6	13
Zambia- CA6	The training aimed to share knowledge on the approach and methods of designing conjoint based study	People in Government,	7	5	12
Zambia – CA6	Enumerator training and kick-start data collection for the research including training on survey tool, allocating blocks of choice sets, selecting participants and the process of product auctioning. A pretest of the survey tools in a nearby village.	Type of individual disaggregates not available,	0	0	16
Zambia – CA2	The workshop was focused on the use of the Fieldbook package to keep/manage inventories in a plant breeding program: <a href="https://excellenceinbreeding.org/toolbox/tools/field-book">https://excellenceinbreeding.org/toolbox/tools/field-book</a>	People in Government, People in Civil Society,	9	11	20
Zambia – CA2	Training was given to the UNZA legume breeding program on how to operate the Mattson cookers to measure cooking time	People in Government,	15	10	25
United States (virtually) – AOI 2.1	Training session one how to make recommendations that farmers will adopt, type of data needs to be collected as part of the agronomic trials, how to calculate net benefits by treatment, how to screen out inferior treatments, how to identify the recommended treatment and how to take the variability of treatment impacts into account.	People in Government, People in Civil Society,	0	0	25



Country of Training	Brief Purpose of Training	Who was Trained	Number Trained		
			M	F	Total
United States (virtually) – AOI 2.1	The main topics covered in this training session include: Discussion of the exercises Example 1- use of current vs. intensive technologies (e.g, fertilizer, herbicide, and insecticide) Example 2- use of different seed varieties What to do if an experimental factor is not statistically significant? Important aspects to consider when designing trials managed by researchers and farmers	People in Government, People in Civil Society,	0	0	25
Ghana AOI 1.1	The training covered a range of topics such as recognizing and defining a research problem, developing a research design, responsible research and innovation, research methods and data collection techniques, validity, reliability, rigor of data collection and analysis, research ethics, open access and open innovation.	Type of individual not available,	2	1	3
Totals			1571	1268	2905*

\*Disaggregation by gender was not available for all short-term training sessions (such as during virtual events) therefore the sum of total male and female trainees is less than total trainees.

## B. Long-term Training

The long-term training in the table below lists students (anonymized based on USAID policy) identified by project PIs and Co-PIs. Of the 65 students in degree granting programs listed below, 31 have completed their programs and received degrees included 12 in FY2023. COVID-19 disrupted the original long-term training plans for several projects that had anticipated training students in the USA. The majority of these projects pivoted to train students in host countries. To complement the in-country training, two project (CA3 and AOI2.2) incorporate visiting scholar visits to universities in the United States.

Table 3: Long-term Training

Trainee Number and Project	Sex	University	Degree	Major	Program End Date (month/year)	Degree Granted (Y/N)	Home Country
1-CA3	Male	University Gaston Berger	Master's	Agronomy and Plant Production	4/2021	Y	Senegal
2-AOI 1.2	Male	University Dan Dicko Danloulodo of Maradi	Bachelor's	Agriculture	12/2022	N	Niger

<b>Trainee Number and Project</b>	<b>Sex</b>	<b>University</b>	<b>Degree</b>	<b>Major</b>	<b>Program End Date (month/year)</b>	<b>Degree Granted (Y/N)</b>	<b>Home Country</b>
3-AOI 2.1	Male	Université des Sciences Sociales et de Gestion de Bamako (USSGB)	Master's	Applied Economic Development	5/2021	Y	Mali
4-AOI 2.1	Male	USSGB	Master's	Geomatics, Land Use Planning, and Management	12/2021	Y	Mali
5-CA3	Female	ENSA – University of Thies	Master's	Agronomy- Soil Sciences	12/2021	N	Senegal
6-AOI 1.2	Female	University of Ouagadougou	Ph.D.	Entomology	2/2024	N	Burkina Faso
7-AOI 1.2	Female	University of Maradi	Ph.D.	Socioeconomics	11/2023	N	Niger
8-AOI 3.1	Female	Universite Norbert Zongo	Master's	Applied Economics	2/2024	N	Burkina Faso
9-AOI 1.2	Female	University of Dedougou	Master's	Entomology	11/2021	Y	Burkina Faso
10-AOI 1.2	Female	University of Maradi	Master's	Entomology	7/2021	Y	Niger
11-AOI 3.1	Female	University of Norbert Zongo	Ph.D.	Applied Economics	3/2024	N	Burkina Faso
12-AOI 1.2	Female	University of Maradi	Master's	Entomology	7/2021	Y	Niger
13-AOI 3.1	Male	University of Norbert Zongo	Master's	Applied Economics	6/2022	Y	Burkina Faso
14-AOI 3.1	Female	Institut Polytechnique Rural de Formation et de Recherche Agricole	Master's	Agricultural Economics	6/2022	Y	Mali
15-AOI 3.1	Male	Institut Polytechnique Rural de Formation et de Recherche Agricole	Master's	Agricultural Economics	6/2022	Y	Mali
16-AOI 1.1	Male	Kwame Nkrumah University of Science and Technology	Master's	Plant Breeding	11/2022	N	Ghana

<b>Trainee Number and Project</b>	<b>Sex</b>	<b>University</b>	<b>Degree</b>	<b>Major</b>	<b>Program End Date (month/year)</b>	<b>Degree Granted (Y/N)</b>	<b>Home Country</b>
17-AOI 1.1	Female	University for Development Studies (UDS)	Bachelor's	Plant Breeding	10/2021	Y	Ghana
18-AOI 1.1	Female	University of Ouagadougou	Master's	Plant Breeding	1/2022	Y	Burkina Faso
19-AOI 2.1	Female	Universite de Thies	Master's	Agricultural engineering	7/2023	Y	Senegal
20-AOI 3.1	Female	Université Nobert Zongo	Master's	Applied Economics	6/2023	Y	Burkina Faso
21-AOI 1.3	Female	University of Thies	Master's	Science and Technology of Seeds	9/2023	Y	Senegal
22 AOI 2.1	Male	Universite de Thies	Master's	Economic and Social Sciences	12/2023	N	Senegal
23-AOI 2.1	Female	Michigan State University	Ph.D.	Agricultural, Food, and Resource Economics	5/2024	N	United States
24-CA3	Male	Cheikh Anta Diop University of Dakar (UCAD)	Master's	Agronomy and cropping systems	12/2023	N	Senegal
25-CA2	Female	North Dakota State University	Master's	Plant Sciences Plant Breeding	07/2023	Y	Zambia
26-AOI 1.1	Male	University for Development Studies (UDS)	Master's	Biotechnology	11/2022	N	Ghana
29AOI 1.1	Female	Universite Saint Thomas D'Aquin	Bachelor's	Agronomy	8/2022	Y	Burkina Faso
30-AOI 1.1	Male	Universite Joseph Ki Zerbo	Bachelor's	Breeding and seed conservation	9/2022	Y	Burkina Faso
31-AOI 1.1	Female	Universite Aube Nouvelle (New Dawn University)	Bachelor's	Agronomy	12/2020	Y	Burkina Faso
32-CA2	Female	University of Zambia	Master's	Plant Breeding and Seed Systems	1/2024	N	Zambia
33-AOI1.2	Female	University of Ouagadougou	PhD	Entomology	4/2024	N	Burkina Faso
34-CA3	Male	UCAD	Master's	Agricultural Economics	8/2022	Y	Senegal

<b>Trainee Number and Project</b>	<b>Sex</b>	<b>University</b>	<b>Degree</b>	<b>Major</b>	<b>Program End Date (month/year)</b>	<b>Degree Granted (Y/N)</b>	<b>Home Country</b>
35-CA4	Male	Lilongwe University of Agriculture and Natural Resources (LUANAR)	Master's	Agricultural Economics	12/2023	N	Malawi
36-AOI1.1	Female	Institut Supérieur de Formation Agricole et Rurale (ISFAR)	Master's	Ag Works Engineer	10/2021	Y	Senegal
37-AOI1.1	Female	ISFAR	Bachelor's	Ag Works Engineer	8/2021	Y	Senegal
38-AOI1.1	Male	UCAD	Bachelor's	SEMENCE (Seed)	11/2020	Y	Senegal
39-AOI1.1	Male	National superior school of agriculture (ENSA)	Master's	Agricultural Engineering	10/2022	Y	Senegal
40-AOI1.1	Female	ENSA	Master's	Agricultural Engineering	10/2022	Y	Senegal
41-CA4	Male	LUANAR	Master's	Agricultural Economics	12/2023	N	Malawi
42-CA4	Female	LUANAR	Master's	Agricultural Economics	12/2023	N	Malawi
43-AOI1.2	Female	INRAN	Master's	Entomology	8/2023	Y	Niger
44-AOI1.2	Male	INRAN	Bachelor's	Entomology	3/2023	Y	Niger
45-AOI1.2	Male	INRAN	Bachelor's	Entomology	3/2023	Y	Niger
46-CA3	Female	UCAD	Master's	Agricultural Economics & Rural Sociology	12/2023	N	Senegal
47-AOI2.1	Female	USSGB	Master's	Geography	12/2023	N	Mali
48-CA3	Male	Université Cheikh Anta DIOP of Dakar (UCAD)	Master's	Agricultural Economics & Rural Sociology	12/2023	N	Senegal

<b>Trainee Number and Project</b>	<b>Sex</b>	<b>University</b>	<b>Degree</b>	<b>Major</b>	<b>Program End Date (month/year)</b>	<b>Degree Granted (Y/N)</b>	<b>Home Country</b>
49-AOI2.1	Male	USSGB	Master's	Local Economic Community Development	12/2023	N	Mali
50-CA3	Male	UCAD	Master's	Agricultural Economics & Rural Sociology	6/2022	Y	Senegal
51-CA3	Male	ISFAR - University of Bambey	Master's	Agronomy and cropping systems	6/2023	Y	Senegal
52-CA3	Female	University Gaston Berger Saint Louis	Master's	Agronomy and cropping systems	3/2023	Y	Senegal
53-CA6	Female	LUANAR	Master's	Agricultural Economics	3/2024	N	Malawi
54-CA6	Female	LUANAR	Master's	Agricultural Economics	3/2024	N	Malawi
55-CA6	Male	LUANAR	Master's	Human Nutrition	11/2023	N	Malawi
56-CA6	Female	LUANAR	Master's	Human Nutrition	11/2023	N	Malawi
57-CA6	Female	University of Zambia (UNZA)	Master's	Agricultural Economics	12/2023	N	Zambia
58-CA6	Female	UNZA	Ph.D.	Agricultural Economics	10/2023	N	Zambia
59-CA2	Female	UNZA	Master's	Plant Breeding and Seed Systems	1/2024	N	Malawi
60-CA2	Female	UNZA	Master's	Plant Breeding and Seed Systems	1/2024	N	Mozambique
61-AOI 2.2	Male	University of Ilorin	PhD	Agricultural Economics	8/2024	N	Nigeria
62-AOI 2.2	Male	Bayero University	PhD	Agricultural Economics	8/2024	N	Nigeria
63 – CA4	Female	LUANAR	MSc	Agricultural Economics	12/2023	N	Malawi
64 – CA4	Male	LUANAR	MSc	Agricultural Economics	12/2023	N	Malawi

<b>Trainee Number and Project</b>	<b>Sex</b>	<b>University</b>	<b>Degree</b>	<b>Major</b>	<b>Program End Date (month/year)</b>	<b>Degree Granted (Y/N)</b>	<b>Home Country</b>
65 – CA4	Male	LUANAR	MSc	Agricultural Economics	12/2023	N	Malawi
66-AOI 2.1	Female	Université Iba Der Thiam de Thiès	MSc	Agricultural Economics	7/2023	Y	Senegal
68-AOI 2.1	Male	Université Assane Seck de Ziguinchor	MSc	Agricultural Economics	12/2023	N	Senegal

## C. Institutional Development

**Description:** The Legume Systems Innovation Lab researchers have access to training and degree (local scientists) opportunities and are furthering their research skills. Various stakeholders, especially farmers/producers, benefit from long- and short-term training supported by the Lab.

During the initial competitive proposal process for all three Areas of Inquiry, the TMAC, AOR, USAID Missions, and ME staff noted the difference in the quality of communicating research proposal ideas between U.S.-based universities and host country institutions. To address this gap, the Legume Systems Innovation Lab has planned a grant writer's workshop for host country scientists to help improve their grant writing and will include a four-part communications workshop led by U.S.-based private sector Bayer Strategic Consulting and individual mentoring from senior researchers.

The Legume Systems Innovation Lab, through the Resilience Resource Team, provided additional technical assistance and capacity grants to ensure that capacity development goes beyond training activities. The RRT provided an initial deep dive assessment of the three newest projects (CA 3, CA 4, and CA 5) on addressing the cross-cutting themes of resilience, youth, gender, nutrition, and HICD. Through a virtual meeting and by email, the RRT advisors provided mentoring and suggestions to enhance project research workplans across these themes. In addition, the second round of competitive funding to incorporate cross-cutting themes in funded research projects was awarded in FY2021, with expert review by RRT advisors and TMAC approval.

Through a competitive grant to address cross-cutting themes in research, nine researchers from Malawi, Mozambique, Zambia, and the U.S. were trained through a gender-responsive plant breeding workshop led by [Gender Responsive Researchers Equipped for Agricultural Transformation \(GREAT\)](#). Following training completion, the Legume Systems Innovation Lab Gender Advisor mentored the researchers to incorporate the new capacity in the research project's work plan with deliberate activities to institutionalize gender-responsive breeding in the bean breeding institutions.

In West Africa, two projects (AOI 2.1 and AOI 3.1) built institutional capacity in communicating policy research more effectively to policy makers and engaging with them through the use of the Kaleidoscope policy model. The GREAT and Kaleidoscope policy model short-term training are examples of how the Legume Systems Innovation Lab seeks to link short- and long-term training to institutional development to provide a comprehensive approach that is sustainable and resilient.

**Partners:** Bayer Strategic Consulting and Resilience Resource Team advisors

## VIII. Innovation Transfer and Scaling Partnerships

The ME continues to focus on innovation transfer, scaling, and outreach strategies of the projects. To emphasize its importance, the ME required each project to work with a Product Lifecycle (PLC) consultant, Joseph Huesing, to identify the stage their technology in the PLC and present information on scaling partnerships and plans and at the Annual Global Convening in Zambia.

Table 4 lists the innovations (technologies, practices, or approaches) as defined by Feed the Future Indicator EG.3.2-7. In FY2023, seventeen innovations are at various stages of development. As detailed in Table 4, thirteen innovations are in the first two phases of development (under research or field testing). The plan of action developed by the ME of the Legume Systems Innovation Lab for innovation transfer and scaling partnership varies by project and host country institution. In the case of the bruchid resistant bean (CA2) breeding project, the project teams has worked through the Beta released Stations of the Innovation 2 Impact (i2i) systems developed under an Associate Award to the Soybean Innovation Lab.



**Table 4. Legume Systems Innovation Lab Technologies by Phase**

Title of Technology/Innovation	Project	FY2023	
		Phase	Count
Biocontrol of Maruca pod borer	AOI 1.2	Phase 2	1
SNP marker assisted backcrossing in cowpea breeding	AOI 1.1	Phase 1	9
SNP marker assisted backcrossing in cowpea breeding	AOI 1.1	Phase 2	3
SNP marker assisted backcrossing in cowpea breeding	AOI 1.1	Phase 3	2
Assessment of ecological interactions between the target pest organisms, the released exotic biocontrol agents and environment	AOI 1.2	Phase 1	1
Assessment of in-field host finding capacity of natural enemies of cowpea pests	AOI 1.2	Phase 1	1
Screening of new isolates of entomopathogenic fungi for improved efficacy	AOI 1.2	Phase 1	1
Farmer Interface Application (FIA)	AOI 1.2	Phase 2	1
Baseline survey for socio-economic adoption, gender and impact studies	AOI 1.2	Phase 1	1
Sequential cowpea cropping under Optimized Shrub System (OSS) management practice	AOI 1.3	Phase 2	1
Bruchid-resistant bean varieties	CA 2	Phase 2	13
Dual-Purpose Cowpea Agronomy	CA 3	Phase 3	1
Legume Composite Flours for Malawi and Zambia	CA6	Phase 1	5
Precooked Beans for Malawi and Zambia	CA6	Phase 1	1
Digital Marketplace for Multi-Stakeholder Platform	CA4	Phase 2	1
SAWBO Video "Using Native Shrubs to Increase Soil Health and Crop Yield"	AOI 1.3	Phase 3	1
SAWBO Video "Neem Tea Bag"	AOI 1.2	Phase 3	1
<b>TOTAL</b>		<b>17</b>	<b>44</b>

**Partnerships made:** In anticipation of release of bruchid resistant bean varieties in three Southern African countries, the ME and CA 2 project researchers have begun discussion to build partnerships with private sector seed companies such as Good Nature Agro in Zambia. Additionally, coordination between the breeders and the partners in the Multi-Stakeholder Platform (CA4) project will introduce the product profiles to potential consumers prior to release. The Kasuwago App (AOI2.2) handed off the technology to Novus Agro through an agreement with Michigan State University to ensure the technology is scaled through the private sector. The ME also worked with USAID to develop sell sheets for cowpea and common bean varieties for showcase at upcoming Ag Tech Fairs and other venues such as AGRF, Seeds2B, and AGRA.

**Technologies ready to scale:** As detailed in Table 4, four innovations are reported in Stage 3 in FY202e and are ready to scale. Two cowpea varieties were approved for release in Ghana with an additional 3, currently in Phase 2, ready for national review. The dual-purpose cowpea agronomy research is ready for policy makers and farmers to apply. Two SAWBO videos ready to scale are SAWBO videos on neem tea bag production (AOI 1.2) and the Optimized Shrub System (AOI 1.3). Other technologies ready to scale but not in Table 4 is an aphid resistant blackeye cowpea, released as California Blackeye 77 from project AOI 1.1, that reached

stage 3 in FY2021. One other innovation supported by the Legume Systems Innovation Lab in Phase 3 but not in Table 4 is the scaling of community-based production of neem bio-pesticides in Niger<sup>4</sup>.

**Technologies transferred:** The Kasuwago App (AOI2.2) was transferred through a legal agreement to Novus Agro. From the Initial Activity projects there are two technologies transferred. First, in Guatemala, the bean variety ICTA Patriarca in Guatemala was released in FY2019 (and therefore not included in Table 4) and available for purchase by seed companies or other entities interested in multiplying seed. Second, suitability maps for pigeonpea and mungbean released in FY2020 (and therefore not included in Table 4) are available for West Africa.

**Technologies scaled:** None to date

## IX. Environmental Management and Mitigation Plan (EMMP)

The initial EMMP included three initial activities that required EMMP – IA1, IA5, and IA6. Prior to FY2021, two Initial Environmental Examination (IEE) amendments, one for IA1 and one for IA5, were submitted and approved. These three initial activity projects concluded prior to FY2021.

The Legume Systems Innovation Lab has submitted and received approval for six IEE amendments for projects concluded in FY2023 in addition to the two for initial activities. IEE amendment #3 for project AOI 1.1 working in Burkina Faso, Ghana, and Senegal to allow for the use of pesticides, fungicides, and herbicides in this improved cowpea breeding project. IEE amendment #4 for project AOI 1.3 working in Senegal to allow for the use of pesticides, fungicides, and herbicides in this project aimed at increasing cowpea yield with the optimized shrub system. IEE amendment #5 for project CA3 working in Senegal to allow for the use of pesticides, fungicides, and herbicides in this project studying agronomic practices of dual benefit cowpea varieties. IEE amendment #6 for project CA2 working in Zambia, Mozambique, and Malawi to allow for the use of pesticides, fungicides, and herbicides in this improved common bean breeding project for bruchid resistance. IEE amendment #7 amending IEE #3 for project AOI 1.1 specifying additional pesticides, fungicides, and herbicides. IEE amendment #8 amending IEE #5 for project CA3 specifying additional pesticides, fungicides, and herbicides. As projects concluded, a Record of Compliance (RoC) was required from PIs.

These six additional IEE amendments have been approved and are now part of the amended EMMP. Prior to purchase, USAID AO purchase approval was obtained. In all cases pesticides, fungicides, herbicides, and fertilizers were properly procured and the storage of chemicals and fertilizers was safe and environmentally sound in accordance with the submitted EMMP and the corresponding IEE amendments and Pesticide Evaluation Report and Safer Use Action Plan (PERSUAP).

An additional IEE amendment (#9) was approved under the USAID Nepal Mission Buy-In for initial desk studies. At the end of FY2023 IEE amendment #10 was submitted for the proposed ongoing activities in Nepal including farmer demo plots.

Proper procurement and storage of fertilizers was safe and environmentally sound. The fertilizers were stored in a locked facility at the research station.

For the transfer of pod borer parasitoids from Benin to Burkina Faso, Niger, and Nigeria, import permits and corresponding phytosanitary certificates were obtained and archived.

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<sup>4</sup> Innovations previously reported in Phase 3 or 4 in previous years cannot be reported again in that same phase unless they are introduced in a new country.

## X. Open Data Management Plan

Legume Systems Innovation Lab funded projects submit Data Management Plans (DMP) in the Legume Resource and Reporting Hub reporting the following: 1) contact person responsible for the data, 2) dataset type; 3) data privacy and restrictions; 4) data processing for privacy impact assessment; 5) date on final data deliverable; 6) estimated publication date and any embargo request; 7) name of the data repository that will be used; 8) responsible party for data submission; and, 9) target submission date. In FY2021, informed consent statements were also collected for research involving human subjects.

Current projects have submitted 37 DMP for datasets in the process of data collection, data cleaning, or data analysis. Five of these DMP were first created in FY2023.

Twenty-seven DMP have targeted submission dates of publications in FY2024. While to date, none are publicly available, four are in the process of submission in USAID's Digital Data Library.<sup>5</sup>

## XI. Governance and Management Entity Activity

### Phase 1 Closeout and Renewal through 2028

During FY2023, USAID extended the Legume Systems Innovation Lab for a second five year phase through August 2028.

### Minority Serving Institutions

As described above, three additional Minority Serving Institutions (MSI) received subawards from the Legume Systems Innovation Lab through an initiative launched in FY2022. All three were represented at the Annual Global Convening in Zambia to present their research. In Phase 2, the Legume Lab will increase the number of MSI engaged in research through inclusion in subawarded projects and collaboration with the Association of 1890 Research Directors.

### Grant Writers Workshop

The five finalists of the Grant Writers Workshop in FY2022 that received Seed Grants presented their research findings at the Annual Global Convening in Zambia. As highlighted in Appendix B, one of the recipients, Richard Atinpoore Atuna, published his research in Nature's Scientific Reports.

### Innovation Lab Council

The Legume Systems Innovation Lab is actively involved in collaboration with other Feed the Future Innovation Labs. In addition to attending the two main Innovation Lab Council meetings, this year Kenya and Washington, DC, the Legume Lab has collaborative working groups including on reporting with Innovation Labs that use Piestar, and a new initiative in FY2023 to standardize the subaward process across Innovation Labs were applicable.

In September 2022, the ME met with the Livestock Systems Innovation Lab to review the current onboarding process for sub-awardees. Onboarding includes introducing a new project and the policies and procedures needed to oversee the flow of funds from USAID through the Legume Lab to the projects. This process ensures regulatory, legal, and credit-related due diligence. From the September 2022 conversation at an Innovation Lab Council meeting, the ME Financial Officer proposed joining forces among financial

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<sup>5</sup> The Digital Data Library is available at <https://data.usaid.gov/>

officers at other Innovation Labs to develop, as much as possible, standardized sub-award guidance. The first meeting of the financial officers took place in March 2023, and continued meeting monthly to discuss common issues and develop common resolutions. As a part of capacity development, the group has merged procedures into a standardized PowerPoint presentation to train and provide overall policies and procedures to sub awardees working with Innovation Labs.

### **Product Life Cycle Framework**

The ME, as a systems Innovation Lab, has adopted and championed the Product Life Cycle (PLC) framework under development by USAID including use of the i2i platform. Indeed, the ME is playing a key role in beta-testing the i2i now. Further, over the past three years, the ME has worked with researchers to apply the PLC framework to project research efforts especially at the earliest stages of new research. However, the ME has taken the PLC approach two steps further. At the request of USAID Washington, the ME presented its vision of the PLC linked to the ME's use of Multistakeholder Platforms (MSP) supported by SAWBO extension materials. Briefly, the MSP serves as an informal network to link the actors throughout a value chain with the goal of identifying needed linkages to facilitate product development, deployment, and scaling. SAWBO animations provide the needed support throughout to ensure training and customer support are available as the technologies deploy and mature. In this way the ME has developed a strategy of MSP/PLC/SAWBO Support that increases the probability of successful product development and rapid scaling ensuring that all of the attributes of the PLC are met.

### **Communications**

The Legume Systems Innovation Lab takes a proactive approach to both internal and external communications.

#### **Internal Communication**

A well-defined internal communications network helps to manage and facilitate interaction between members of the ME, projects, advisory boards, and USAID. To ensure cohesive program management, the ME holds weekly team meetings where each team member shares updates and concerns in their area of expertise.

#### **Project Engagement**

The ME also understands the importance of good communication with projects. PIs receive a monthly email which includes important program updates and industry news. In addition, the ME holds a semi-annual check-in call with each project individually to ensure metrics are being met and issues addressed. The Piestar reporting system also provides a reliable and consistent software platform to ensure proper capturing of data and project narratives on a timely basis.

#### **Advisory Board Engagement**

To ensure the ME is enlisting the TMAC and LINCC advisory boards to their fullest advantage, a regular meeting schedule and written expectations are communicated and updated as necessary.

#### **USAID-DC Engagement**

Communication with USAID is essential for program success. The ME holds bi-weekly calls with the AOR to address accomplishments, challenges, and expectations implementing an adaptive management style.

#### **USAID Mission Engagement**

The Legume Systems Innovation Lab seeks to communicate timely updates to the county and regional USAID Missions and Offices covering the host countries in which research is active. The Legume Systems Innovation Lab directors and researchers held many in-person meetings with Missions. The ME was diligent in keeping Missions informed of program personnel travel and coordinated in-person visits whenever possible.

### **External Communications**

External communications for the Legume Systems Innovation Lab focus on a proactive strategy designed to promote legume research milestones and innovations, the nutritional benefits of legumes, the unique nitrogen fixing capabilities of legumes, and their importance to smallholder farmers as both a cash crop and a reliable food source for their families and livestock.

The Legume Systems Innovation Lab utilizes several mediums to execute the external communications strategy. These include an updated project [website](#), monthly electronic newsletter, active social media accounts focused on X (formally twitter) and Facebook, and articles submitted to Agrilinks, Feed the Future newsletter, and industry and consumer publications.

In FY2023 the program worked on several project videos to highlight the importance of beans in Southern Africa. Video recordings of program and project presentations and events such as the Annual Global Convening are also made available on the program [YouTube channel](#), website, and are highlighted in the monthly newsletter.

The ME also encourages projects to author peer reviewed publications, policy briefs, articles, and research papers.

In addition, program and project personnel often attend and make presentations at industry events to further the scientific knowledge and importance of legumes globally.

## **XII. Other Topics**

### **Resilience Resource Team**

The Legume Systems Innovation Lab supports the integration and mainstreaming of five USAID cross-cutting themes of gender, human and institutional capacity development, youth, nutrition, and resilience to activities of funded projects. To assist projects in identifying strategies and interventions to further incorporate these themes, the Legume Systems Innovation Lab has established the Resilience Resource Team (RRT). The RRT is comprised of advisors in each of the cross-cutting areas plus monitoring and evaluation and project management advisors.

In FY2023, the RRT conducted a review of its work with a publication expected in FY2024. RRT member Jane Payumo presented the paper “Cross-cutting themes and opportunities for global collaborative research and networks,” at the International Network for the Science of Team Science (INSciTS) 2023 Conference in Bethesda, MD in July 2023.

## **XIII. Issues (financial, management, regulatory)**

### **Unique Entity ID (UEI)**

In FY2023, the ME dedicated significant effort and time to assist international subaward institutions obtain UEIs as required by USAID. The temporary waiver received for one subaward institution, INRAN, allowed work to begin while the UEI was in process. There are several previously documented challenges of the SAM.gov and UEI process for international entities seeking to work with USAID or prime award such as the Legume Systems Innovation Lab. To address the time it takes institutions to obtain UEIs, the Innovation Lab has proactively provided instructions to institutions that plan to submit proposals to also request the UEI from the partner institutions (or sub-subawards).

### **Capacity of non-US institutions**

With partner institutions in our target regions we have routinely had difficulty moving funds to our partners, both NARS institutions and CGIAR institutions. There are a number of layers in this difficulty that we will outline here:

1. Cash flow: Partner institutions, generally, do not have financial liquidity that would allow for them to cover project spending until invoices are accumulated and submitted for reimbursement. This means that the ME must in some way acquire cash advances for partner institutions from our host institution (in this case, Michigan State). This is a lengthy and laborious process. We have addressed this by making advances part of the contracting process so that contract approvals and cash advance approval occur simultaneously rather than sequentially.
2. Unique Entity ID: The introduction of the UEI has delayed approvals, funding, and implementation. The UEI system is broken, to be quite honest. We have not found an adequate solution to this problem but would recommend that international partners be allowed to authorize North American partners, like the Management Entity, to assist with the processing of the paper work for submission. As things currently stand, the US partners have no access to the submission of partners and are unable to correct mistakes or provide additional information. Another barrier is that the UEI helpline does not support languages other than English. The result is that some of our partners are working through US legal jargon in a second language and in many cases have to guess at what both the formal application is asking for or what the assistants on the helpline are referring to. It would be useful if US partners were allowed to work through this documentation together with international partners to ensure that the right information is submitted in a timely fashion.
3. Bank transfers: International bank transfers are proving to be difficult. Often, transfers are returned without much explanation. It is left to the ME to trace transfers, find the problems, contact the right financial institution and the right institutional representative, inquire and request corrections, and rewire funds. This is all a very time consuming process. There are currently no adequate solutions to this problem other than somehow reforming the regulations governing international bank transfers.
4. Financial reporting: Our international partners have had difficulty understanding reporting procedures and submitting proper documentation for reimbursements. We have found two workarounds. 1) Our fiscal officer works directly with the partner institutions to give adequate orientation and training for financial personnel. This becomes complicated when partner subawardees in turn make subawards with partner institutions in the region. The number of institutions needing training multiplies logarithmically. 2) In the second phase, financial training will take place prior to the end of the contracting process so that capacity development is not simply reactive. 3) In the second phase we will be appointing regional coordination entities. The ME will train these coordinators directly on financial reporting and the regional coordination will be responsible, in turn, for training and giving oversight to all regional partner institutions, whether subawardees, or subawardees of subawardees.

### **Backdating of contracts**

As of February, 2023, we are no longer allowed to 'backdate' the start date of subawards or contracts as we had in the past. This may have been a policy change at USAID, or simply the decision to start enforcing an

interpretation of existing policies. Either way, it resulted in a change in practice that we were not expecting. As a result, a large amount of expenses (over \$40,000) had to be funded from other sources since the backdating was not allowed to occur as it had in the past. In the past, we had been able to back date approved contractual agreements, whether subawards or professional services contracts, to the beginning of activity described in the scope of work. This allowed us to get activities started while the contractual approval process was underway. Approvals can often take time, leading to unacceptable delays in activity. The commencement of activities was always undertaken knowing the risk that the contracts might not be approved by USAID, but in most cases, the high probability of successful approvals and the higher risks of delays in starting made it worthwhile. Backdating the contracts to the start of activities allowed the costs incurred in interim between commencing activities and final approvals to be covered once the subawards or contracts were approved. This is no longer allowed by USAID AOs. Our current solution to this issue is to simply not start activities until all contracts are in place. This is not preferable, however, since in many cases the timelines of the activities are too short to support the lengthy delays in acquiring approvals. Instead, we would like to recommend that a mechanism be put in place that would allow us to submit a letter of intent notifying USAID of the commencement of activities and allowing USAID to acknowledge the receipt of the notification while not committing to funding the activities. The acknowledgement would be supported by all the appropriate caveats and disclaimers from USAID, reminding applicants that the acknowledgement was not an approval and that any costs incurred prior to approval would not be supported if approval were not granted. In this way, subawards and contracts could be dated to the date of acknowledgement rather than the date of the approval of the subaward or contract once approvals were acquired. In this way the ME would be able to assess the risk of beginning activities knowing full well that there might always be a possibility that the subawards or contracts might not be approved and that expenses incurred may not be reimbursed.

## XIV. Future Directions

### **Phase Two Implementation and Changes**

On August 23, 2023, the Legume Systems Innovation Lab was extended for a second five-year phase. FY2024 begins with the ME commissioning up to four research projects that will carry forward promising innovations from the first phase that are near release in the product life-cycle framework. Additionally, the ME is adjusting the Technical Management Advisory Committee (TMAC) to the Technical Leadership Team (TLT) as described below in preparation for Regional Stakeholder Convening in FY2024 in preparation for Requests for Proposals.

The ME plans to include the Central American countries of Honduras and Guatemala in the eligible countries for researchers to propose work as well as expand its focus in the African Great Lakes region in alignment with the expanded Feed the Future countries.

### **Technical Leadership Team**

The ME has worked successfully with the TMAC throughout phase one (2018-2023) of the Legume Systems Innovation Lab but identified two areas that were not being addressed. First, the TMAC members' knowledge and wisdom were not fully exploited in the implementation of the research agenda. Secondly, the TMAC did not have representation by members with expertise in key areas of legume system development. For the second phase, the ME will restructure the TMAC and replace it with a Technical Leadership Team (TLT). The function of the TLT will represent key system area and play an active role in identifying system gaps in the area of those key system functions. The four areas that the ME has identified as key system functions are:

- Seed systems and varietal development



- Value chains and system integration
- Climate change and resilience [inclusive of integrated pest management (IPM)]
- Gender, Equity, and Social Inclusion expert (provided by the RRT)

All or a subset (where appropriate) of the TLT members will be brought on as commissioned activities and will have an active role in the development of the legume systems in the four geographic regions where we have proposed to work. Initially in FY2024, the TLT members will:

- Conduct a preliminary evaluation of the target regions in their area of expertise and present the findings at the initial Regional Stakeholder Conferences (RSC) as detailed below
- Assist with the development of Requests for Proposals (RFPs) for each region
- Serve as advisors to the ME in the selection of research proposals for funding
- Serve as advisors to the RSCs and the regional lead

### **Regional Stakeholder Convenings**

The Legume Systems Innovation Lab will commission a regional entity to serve as the regional lead. The purpose of the commissioned group will be to host the annual Regional Stakeholder Conferences (RSCs). The initial RSC will be for the purpose of hearing the results of the value chain analysis, the seed system analysis, and the resilience analysis led by the members of the TLT. From these data and the experiences of the stakeholders, a systems gap analysis will be conducted to identify efficiency and effectiveness gaps in the current legume production systems. Stakeholders will include not only value chain actors, but also policy makers, service providers, as well as USAID missions and other relevant donor agencies and NGOs. Together with the identification of gaps, the RSC will identify system level impacts and indicators that will be measured in order to track progress toward the goals over the five-year, second phase of the Lab. In response to the identification of gaps and indicators to be measured, each region will set a prioritized research agenda for the region that will advance the region toward the desired system goals. From these research priorities, the TLT and the ME will craft the RFPs for the competed awards. The regional lead will then be responsible for convening annual stakeholder conferences. The stakeholder conferences will continue to monitor and measure progress toward the system goals articulated in the initial RSC. The regional lead will be responsible for tracking data on the identified system-wide indicators and reporting progress out to the RSC in the annual RSC meeting. Adjustments to region-wide strategies will then be taken to ensure that research taking place is already or in the near future will be poised to directly affect the improvement of system-wide indicators.

## Appendix A: List of All Awards Given to Partners

**Title:** Sustainable Insect Pest Management for Cowpea in West Africa

**Awarded institution:** International Institute of Tropical Agriculture

**Dates:** January 1, 2019 – June 30, 2020

**Current year funding:** \$0

**Total funding:** \$69,839

**Title:** Systems Research to Identify Legume Options for Sustainable Intensification: Pigeon pea as a Test Case for Scaling in West Africa

**Awarded institution:** Michigan State University (USA)

**Dates:** January 1, 2019 – June 30, 2020

**Current year funding:** \$0

**Total funding:** \$100,000

**Title:** Selection and Release of Climate Resilient Common Bean Germplasm for the Highlands and Dry Corridor of Central America

**Awarded institution:** North Dakota State University (USA)

**Dates:** January 1, 2019 – June 30, 2020

**Current year funding:** \$0

**Total funding:** \$52,000

**Title:** Enhancing Resilience and Nutrition in the Peanut Basin of Senegal through Integration of Newly Released, Improved Cowpea Varieties

**Awarded institution:** Kansas State University (USA)

**Dates:** January 1, 2019 – June 30, 2020

**Current year funding:** \$0

**Total funding:** \$50,000

**Title:** Measuring Cowpea Consumption

**Awarded institution:** Washington University in St. Louis (USA)

**Dates:** January 1, 2019 – March 31, 2021

**Current year funding:** \$0

**Total funding:** \$132,725

**Title:** Development of Market-Driven Improved Cowpea Varieties for West Africa using Mature-Markers

**Awarded institution:** University of California Riverside (USA)

**Dates:** November 1, 2019 – June 15, 2023

**Current year funding:** \$196,392

**Total funding:** \$775,000

**Title:** Science-driven and Farmer-oriented Insect Pest Management for Cowpea Agro-ecosystems in West Africa

**Awarded institution:** International Institute of Tropical Agriculture<sup>6</sup>

**Dates:** November 1, 2019 – June 15, 2023

**Current year funding:** \$192,125

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<sup>6</sup> IITA's award includes MSU based researchers and Legume Systems Innovation Lab project coordination in Ghana through Africa RISING. The MSU portion of the total award funding is \$105,795. The Africa RISING portion of the total award funding is \$60,000.

**Total funding:** \$834,205

**Title:** Optimized Shrub System (OSS): An Innovation for Improving Cowpea Yields and Strengthening Smallholder Resilience in Senegal

**Awarded institution:** Ohio State University (USA)

**Dates:** November 1, 2019 – June 15, 2023

**Current year funding:** \$37,352

**Total funding:** \$99,651

**Title:** Quantifying the Scale and Scope of Nutritious Cowpea Products in Local Markets of West Africa

**Awarded institution:** Michigan State University (USA)

**Dates:** November 1, 2019 – June 15, 2023

**Current year funding:** \$281,627

**Total funding:** \$774,041

**Title:** Promoting Trade Integration in Regional Legume Markets with Mobile Technology

**Awarded institution:** Michigan State University (USA)

**Dates:** January 1, 2020 – June 15, 2023

**Current year funding:** \$297,684

**Total funding:** \$775,000

**Title:** How Input Subsidy Policies Change the Cowpea Farming Landscape in West Africa

**Awarded institution:** Michigan State University (USA)

**Dates:** November 1, 2019 – March 31, 2022

**Current year funding:** \$0

**Total funding:** \$347,329

**Title:** Baseline Value Chain Assessment for Key Legume Markets in West Africa

**Awarded institution:** Michigan State University (USA)

**Dates:** April 1, 2019 – April 30, 2020

**Current year funding:** \$0

**Total funding:** \$103,922

**Title:** Genetic Improvement of Dry Beans for Bruchid Resistance for Southern Africa

**Awarded institution:** North Dakota State University (USA)

**Dates:** March 15, 2020 – June 30, 2023

**Current year funding:** \$153,868

**Total funding:** \$843,111

**Title:** Sustainable Intensification of Dual-Purpose Cowpea Varieties for Enhanced Food and Fodder in Senegal

**Awarded institution:** Kansas State University (USA)

**Dates:** May 1, 2020 – June 15, 2023

**Current year funding:** \$81,261

**Total funding:** \$401,366

**Title:** Transforming seed systems to respond to bean variety demand through multi-stakeholder platforms in Malawi

**Awarded institution:** Alliance of Bioversity International and CIAT

**Dates:** June 1, 2021 – June 15, 2023

**Current year funding:** \$227,129

**Total funding:** \$750,000

**Title:** Cowpea Atlas in West Africa: Mapping Cowpea Data Sources and Gaps in West Africa  
**Awarded institution:** Institut Sénégalais de Recherches Agricoles (ISRA) Regional Center of Study for the Improvement and Adaptation to Drought (CERAAS),  
**Dates:** June 1, 2021 – June 15, 2023  
**Current year funding:** \$304,889  
**Total funding:** \$548,205

**Title:** Improving Incomes and Nutrition Security Through Development and Commercialization of Consumer Preferred Processed Legume-based Products in Malawi and Zambia  
**Awarded institution:** Alliance of Bioversity International and CIAT  
**Dates:** December 9, 2021 – June 30, 2023  
**Current year funding:** \$295,415  
**Total funding:** \$775,000

**Title:** Feed the Future Innovation Lab for Legume Systems Research (Management Entity Salary and Expenses for Director and Deputy Director)  
**Awarded institution:** Purdue University (USA)  
**Dates:** January 19, 2021 – August 22, 2028  
**Current year funding:** \$1,061,946  
**Total funding:** \$5,535,228

**Title:** Legume System Network Mapping for West and Southern Africa Regions  
**Awarded institution:** Emerging Ag Inc.  
**Dates:** October 1, 2020 – April 30, 2021  
**Current year funding:** \$0  
**Total funding:** \$147,609

**Title:** Strategic Collaborations: Implementing a Gender-Responsive Genetic Improvement Program for Bruchid Resistant Dry Beans in Southern Africa  
**Awarded institution:** University of Zambia  
**Dates:** May 15, 2021 – June 15, 2023  
**Current year funding:** \$18,632  
**Total funding:** \$54,530

**Title:** USAID/Niger Buy-In  
**Awarded institution:** Purdue University (USA)  
**Dates:** July 1, 2022 – February 1, 2024  
**Current year funding:** \$32,699  
**Total funding:** \$75,865

**Title:** USAID/Niger Buy-In  
**Awarded institution:** L' Université Dan Dicko Dankoulodo de Maradi  
**Dates:** July 1, 2022 – February 1, 2024  
**Current year funding:** \$31,000  
**Total funding:** \$68,999

**Title:** USAID/Niger Buy-In  
**Awarded institution:** Institut National de la Recherche Agronomique Du Niger (INRAN)  
**Dates:** July 1, 2022 – February 1, 2024  
**Current year funding:** \$10,000  
**Total funding:** \$33,000

**Title:** USAID/Niger Buy-In  
**Awarded institution:** IITA  
**Dates:** July 1, 2022 – February 1, 2024  
**Current year funding:** \$7,000  
**Total funding:** \$15,000

**Title:** Exploring Regional Food Hubs in West Africa  
**Awarded institution:** California State University, Chico  
**Dates:** August 1, 2022 – June 30, 2023  
**Current year funding:** \$30,000  
**Total funding:** \$30,000

**Title:** Development and Release of Common Bean Germplasm Having Multiple Virus and Bruchid Resistance  
**Awarded institution:** University of Puerto Rico, Mayaguez  
**Dates:** August 1, 2022 – June 30, 2023  
**Current year funding:** \$30,000  
**Total funding:** \$30,000

**Title:** Measuring the Impact of Digital Technologies on Informal Traders Productivity  
**Awarded institution:** Georgia State University  
**Dates:** August 1, 2022 – June 30, 2023  
**Current year funding:** \$30,000  
**Total funding:** \$30,000

**Title:** USAID/Nepal Buy-In  
**Awarded institution:** Purdue University  
**Dates:** April 17, 2023 – February 1, 2024  
**Current year funding:** \$350,000  
**Total funding:** \$ 563,120.36

**Title:** USAID/Nepal Buy-In  
**Awarded institution:** Alliance of Bioversity International and CIAT  
**Dates:** April 17, 2023 – February 1, 2024  
**Current year funding:** \$ 63,228.00  
**Total funding:** \$ 63,228.00

## Appendix B: Success Stories

### Recipient of Legume Lab grant writing workshop and competition publishes paper on research of pigeon pea flour

A capacity building activity of the Feed the Future Innovation Lab for Legume Systems Research has culminated in the publication of an article on the characteristics of pigeon pea flour as a food ingredient for one researcher. The Grant Writers Workshop and Seed Grant Competition provided researchers from target African countries the opportunity to attend a two-week workshop to improve their grant writing skills and submit a proposal for research supported by the Legume Systems Innovation Lab.

Richard Atinpoore Atuna, a lecturer in the department of food, science, and technology at the University for Development Studies in Tamale, Ghana was one of 40 legume researchers selected for the workshop and subsequent winner of one of five grants awarded. His research findings on the project titled, Improving the Nutritional Qualities and Utilization of Cowpea and Pigeon Pea Using Household-level Processing Methods were recently published in Nature's Scientific Reports.

The workshop was led by science communication expert, Mark Bayer of Bayer Strategic Concepts. Bayer, developed the RISE system (Raising the Influence of Scientists and Engineers), uses a unique blend of proven rhetorical tools, persuasion principles, and communications techniques to help scientists boil down their work into jargon-free, and engaging narratives to secure funding and advance their careers.

The workshop participants, who were chosen through a competitive concept note submission process, worked collectively and one-on-one with Mark to hone their writing and speaking skills. They then submitted proposals based on their winning concept notes to the Legume Systems Innovation Lab. Recipients of five grants then went to work on their one-year projects.

The workshop was open for research in any aspect of the legume value chain specific to the Legume Systems Innovation Lab's target crops of cowpea, pigeon pea, or common bean for work in any of the program's target countries of Benin, Burkina Faso, Ghana, Malawi, Mali, Mozambique, Niger, Nigeria, Senegal, and Zambia. Over 70 concept notes were submitted to the popular workshop.

The grant recipients also showcased their enhanced presentation skills to over 100 global legume researchers when they presented their research as invited guests at the Legume Systems Innovation Lab 2023 Global Convening held in Livingstone, Zambia. The event also provided the researchers a great networking opportunity.

Atuna's article, "Physico-functional and nutritional characteristics of germinated pigeon pea (*Cajanus cajan*) flour as a functional food ingredient" explores the effect of germination on pigeon pea flour's pH, color, water and oil absorption, swelling and foaming capacities and bulk densities and food components such as moisture, ash, fats and oils, protein and carbohydrates. The finding indicate that "germinated pigeon pea flour will perform better in formulating baked product, aerated foods and food extenders than non-germinated pigeon pea flour. Hence, the germination of pigeon peas should be encouraged because it harnesses the functional and proximate attributes measured."



*Richard Atinpoore Atuna from the University for Development Studies in Ghana presents during the Legume Systems Innovation Lab 2023 Global Convening.*

“We are thrilled with the results of this capacity building activity,” shares John Medendorp, Legume Systems Innovation Lab Deputy Director. “Richard’s publication is the first from this activity, but I have no doubt that it will be followed by others. The level of research output from this small but motivated group has been inspiring.”



## Innovation Lab supports 65 students in degree granting programs globally

The Feed the Future Innovation Lab managed by Michigan State University supported a total of 65 students in legume research related educational degrees at numerous higher-learning institutions globally during the first five-year phase of the program.

“This accomplishment shows the commitment of the Legume Systems Innovation Lab to build individual capacity for resilient development,” shares John Medendorp, deputy director of the program. “In order for developing countries to shift the needle, investments in people are one of the strongest influencers we as programs can provide.”

Barry Pittendrigh, Legume Systems Innovation Lab Director notes, “it’s a model that U.S. land grant universities can lend to our partner countries. A model based on understanding the issues within a community and finding applicable solutions to solve those issues. By investing in the next generation of legume researchers, we are building resilience with these educated problem solvers to understand, react to, and withstand shocks and issues within their communities.”

Maria Mazzala from Zambia is one of the 37 females awarded a scholarship through the Legume Systems Innovation Lab. She recently received her master’s degree in plant sciences at North Dakota State University. “This program has helped me solidify my confidence to become the best version of me. I am extremely grateful.”

Supported through the project, *Genetic Improvement of Dry Beans for Bruchid Resistance for Southern Africa*, her advisor, and project principal investigator Dr. Juan Osorno has been pleased with Maria’s dedication to her field and Zambia. Three other students are also supported by the project and are studying at collaborating institution, the University of Zambia.

“To describe Maria and the other students I would have to say they are passionate, dedicated, and aim for excellence. I commend my colleague, Dr. Kelvin Kamfwa from the University of Zambia for recruiting really good students (and) selecting the right people for this project. We have four amazing women who are working with us. These students are going to go back (to their home countries) and make real impact into the regions.”

Although the students working with Dr. Osorno and Dr. Kamfwa are involved in bean breeding, legume research is no longer just about the farm. Economics and policy also play an integral role.

“Almost half of these students pursued degrees in Agricultural Economics and related fields like land use, planning, and management, local economic and community development, or nutrition. These fields really dive deep into the legume value chain and our systems approach of social and community issues which are critical for sustained growth,” adds David DeYoung, Legume Systems Innovation Lab Program Manager.

In summary, the Legume Systems Innovation Lab supported nine bachelor students, eight doctoral students, and 48 master’s degree students from ten countries studying at 23 higher education institutions in Africa and the U.S. Of the 65 students, 37 were female and 28 males.



*Maria Mazala with Dr. Juan Osorno and Dr. Kelvin Kamfwa in the greenhouse at the University of Zambia.*

## Public and Private Sectors Unite to Support Nepal Lentil Farmers in Lumbini Province

Lentil is an important crop in Nepal for nutrition, soil health, and as both a staple and export commodity. However, crop yields have become stagnant with the low productivity attributed mainly to stressed environmental conditions and agronomic practices.

This reduced efficiency led the United States Agency for International Development (USAID) Nepal to commission the Feed the Future Innovation Lab for Legume Systems Research to launch the project, *Transforming the Lentil Sector in Nepal*.

The project, led by Michigan State University, organized lentil multi-stakeholder platforms (MSP) in several key Nepal growing regions. MSPs provide “spaces” for learning and knowledge exchange where various stakeholders come together to diagnose their challenges and identify opportunities to address them that are mutually benefiting.

The project-organized MSP in the Lumbini Province includes 26 members representing lentil farmers, millers, and processors; government; development; and private sector lentil value chain actors. The self-governing MSP has secured financial support from the Ministry of Agriculture and Land Management, Lumbini Province and support by private sector Muktinath Krishi Company Ltd.

“This MSP has exceeded our expectations for growth and development in such a short period of time,” explains Legume Systems Innovation Lab Program Manager David DeYoung. “We first convened this group in April to introduce the MSP concept and when we met again in July, just a couple months later, the MSP had already secured funding from the local government to support activities. During the July meeting the MSP was able to define a workplan to test improved lentil varieties for the upcoming growing season. This workplan was further enhanced when MSP private sector partner Muktinath Krishi committed extension services and guaranteed to purchase the harvest crop.”

The MSP is now in the final planning stages for their upcoming variety trials which will also build smallholder farmer knowledge through Muktinath Krishi’s oversight and education of good lentil agricultural practices.

By linking public and private sector the project’s vision of MSPs as drivers for sustainable growth of the Nepal lentil sector is coming to fruition. Goals for the MSP are to identify varieties that are stress resistant, nutritionally biofortified, high yielding, and consumer preferred and provide strategies for farmer variety adoption. They will also take a closer look into lentil seed and market systems to identify bottlenecks and weak points from seed/variety availability from the producer level all the way through to lentil market and export. A special focus will be made on the varietal nutritional panels and potential advantage for nutrition fortified varieties. Multi-variety trials will be conducted to ensure selected varieties respond to localized trait and preference requirements.

Ram Prasad Pandey, Directorate of Agriculture Development, Ministry of Agriculture and Land Management in the Lumbini province, is a member of the Lumbini lentil MSP. He explains why the local government supports the MSP. “Lentil is a very important crop of Nepal because it has potential of trade promotion as well as farmer income. In the past decades, lentil was grown in more area with more production and higher productivity. But these days, the area production and productivity is in a decreasing rate, decreasing trend. So, we need more support to the lentil sector to improve its productivity as well as to increase area and production. We have to work with farmers, private sector and all these stakeholders together to increase area production and productivity. All this could be helpful for nation.”



*"We face a lot of problems as lentil farmers but we also know that we can have good production if we have the right support. Now that I am in the steering committee for the MSP, I will do my best to address the issues faced by my farmer brothers and sisters coming from different financial situation, ethnic groups, social conditions," Laxmi Karki Bohora, Lentil farmer and cooperative member during MSP workshop in Lumbini Province.*

## Appendix C: Legume Systems Innovation Lab Fact Sheet

The Legume Systems Innovation Lab Fact Sheet is available on the next pages.





# FEED THE FUTURE

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

## FEED THE FUTURE INNOVATION LAB FOR LEGUME SYSTEMS RESEARCH

The Feed the Future Innovation Lab for Legume Systems Research is a five-year research capacity building development program managed by Michigan State University that focuses on grain legumes in West and Southern Africa. Legumes are a nutrient-dense staple crop that have multifunctional roles in smallholder farm systems in developing countries including food and nutrition security, generating income, providing livestock feed and fodder, and contributing to the sustainability of soil systems through their nitrogen-fixing capabilities. Cowpea and common bean are the focal crops of the Legume Systems Innovation Lab.



The strength of the Legume Systems Innovation Lab's design lies in its innovative and vibrant research to scaling strategy using a systems approach. Supported projects are diverse in research focus and address both the development and placement of innovative technologies with a thorough understanding of the systems they will impact thus leading to successful adoption. Projects are focused in three areas of inquiry (AOI)



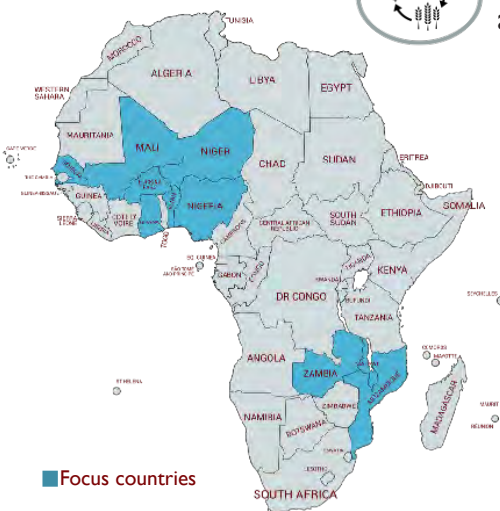
AOI-1 Integration of legumes into sustainable smallholder farming systems and agricultural landscapes



AOI-2 Integration of legumes within local and regional market systems, including trade



AOI-3 Analysis of motivators or barriers to legume utilization within social and economic systems



The Legume Systems Innovation Lab goals include inclusive and sustainable agriculture-led economic growth, strengthened resilience among people and systems, and a well-nourished population, especially among women and young children.

In addition, the Legume Systems Innovation Lab will focus on opportunities that address nutrition, the unique needs of women and youth, ensure greater resilience of people and systems under stress and shocks, and contribute to the development of human and institutional capacity for a resilient agricultural innovation system.

The Legume Systems Innovation Lab is funded by USAID under the Feed the Future Initiative.



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# FEED THE FUTURE INNOVATION LAB FOR LEGUME SYSTEMS RESEARCH

Legume Systems Innovation Lab projects are driving innovations in legume insect pest management, new and enhanced variety breeding, alternative cropping systems, technology adoption in trade systems, nutritional approaches, and policy effects on the system. Additional projects will address gaps within our systems approach knowledge base to provide a greater understanding for successful innovation scaling.

## Projects

### Farming Systems

- Development of Market-Driven Improved Cowpea Varieties Using Mature-Markers
- Optimized Shrub System: Improving Cowpea Yields and Strengthening Smallholder Resilience
- Science-Driven and Farmer-Oriented Insect Pest Management for Cowpea Agro-Ecosystems



### Market Systems

- Promoting Trade Integration in Regional Legume Markets with Mobile Technology
- Quantifying the Scale and Scope of Nutritious Cowpea Products in Local Markets

### Social & Economic Systems

- How Input Subsidy Policies Change the Legume Farming Landscape



[www.feedthefuture.gov](http://www.feedthefuture.gov)  
[www.canr.msu.edu/legumelab](http://www.canr.msu.edu/legumelab)



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## Appendix D: Legume Systems Innovation Lab Monthly e-Newsletter

The Monthly e-Newsletters are available on the next pages.



## FEED THE FUTURE INNOVATION LAB FOR LEGUME SYSTEMS RESEARCH

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October 2022



The Feed the Future Innovation Lab for Legume Systems Research fosters dynamic, profitable, and environmentally sustainable approaches that contribute to resilience, productivity, and better nutrition and economic opportunities. The lab is managed by Michigan State University.

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### *From the Management Office*

#### Legume Lab Receives Funding from USAID Niger Mission to Improve Cowpea Production



A new project, *Improving Cowpea Production in Niger* will be managed by the Feed the Future Innovation Lab for Legume Systems Research led by Michigan State University. The project is funded by the United States Agency for International Development (USAID) Niger Mission.

One activity of the project focuses on integrated pest management (IPM) solutions for cowpea farmers. Over

the past decade, the National Agricultural Research Institute of Niger (INRAN), the University of Maradi, the International Institute for Tropical Agriculture (IITA), and Scientific Animations Without Borders (SAWBO) have created and tested the use of animations in local languages to train farmers on better strategies for controlling insect pests without the need for second-generation chemical pesticide sprays. Published research has demonstrated that integration of animations into IPM training efforts has highly positive impacts on farmer learning and adoption of the techniques ([e.g., 89% adoption rates by farmers for post-harvest loss prevention techniques; Bello-Bravo et al., 2020](#)).

The project will use these creative tools towards development of a pan-Niger deployment network using a systems approach that can be used to continually

scale other content beyond the scope of the project.

The second activity of the project will develop a cowpea variety process map based on the cowpea variety product life cycle with a main focus on identifying varieties carrying key traits as outlined by the Niger USAID Mission for scaling over the next three years.

The product development map will serve downstream varietal scaling release assessments for use after the end of the project while the varietal recommendations will serve the immediate need for scaling recommendations. Having identified stakeholders in the cowpea product development lifecycle, the project will also initiate a Cowpea '*Community of Practice*' with the aim of building longer-term capacity in cowpea product development.

Project partners include Niger National Institute of Agricultural Research (INRAN), the University of Maradi, International Institute of Tropical Agriculture (IITA), and Scientific Animations Without Borders (SAWBO).

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## GLOBAL VIRTUAL CONVENING 2022

Over 100 global legume researchers and stakeholders attended the two-day public forum virtual event in March which featured Legume Systems Innovation Lab project research updates.

Each month we will highlight a recorded presentation from one of these research projects.

This month we feature the project, "**Genetic Improvement of Dry Beans for Bruchid Resistance for Southern Africa.**" The project is led by Dr. Juan Osorno, North Dakota State University and works in Zambia, Malawi and Mozambique. The presentation is given by Dr. Kelvin Kamfwa, Co-PI from the University of Zambia.

**Click on the image below to view the presentation on YouTube.**



## *In the Field*

### KasuwaGo Co-Sponsors the Future of Commerce 2022 Conference



*Michigan State University Assistant Professor, Michael Olabisi during the TechCabal Future of Commerce 2022 conference.*



*The KasuwaGo booth attracted many visitors during TechCabal 2022.*

KasuwaGo is proud to have co-sponsored The Future of Commerce 2022 conference which was organized by TechCabal. The well-attended event, which happened in Lagos, Nigeria on September 23rd, brought together influential business leaders from across the world to share experiences on how commerce is evolving and shaping up across the African continent, and how stakeholders can adequately prepare for these changes. It created an excellent opportunity to meet stakeholders across-many sectors to network and find potential partners.

The Future of Commerce conference was centered on tech and commerce, which fits the purpose for KasuwaGo, a trading app created in response to conversations with legumes farmers and sellers seeking better market connections and economic opportunities within a resilient food system, using mobile-phone technology.

The KasuwaGo app is the flagship of the research project titled, *Promoting Trade Integration in Regional Legume Markets with Mobile Technology* which is led by Dr Michael Olabisi from Michigan State University and is funded by the Feed the Future Innovation Lab for Legume Systems Research.

[Learn More](#)

## *In the News*

### Michigan State University Welcomes Visiting Legume Scholars



The Legume Lab recently welcomed Nigerian researchers, Dr. Toyin Benedict Ajibade, pictured far right, and Dr. Hakeem Ajeigbe, pictured far left, to our Michigan State University offices.

The two are working on the project, *Promoting Trade Integration in Regional Legume Markets with Mobile Technology*, which is led by MSU professor Michael Olabisi, pictured middle.



## Peer Reviewed Publication

Smale, Melinda & Theriault, Veronique & Allen, Andrea & Sissoko, Mamadou. (2022). [Is cowpea a 'women's crop' in Mali? Implications for value chain development](#). 17. 157-170. 10.53936/afjare.2022.17(2).11.

## Featured Legume of the Month

### Common Green Bean



Common beans are best known as green beans, string beans, or french beans. They can be eaten fresh with the pods or the beans can be dried and stored.

They are an easy crop to grow and are often found in many home gardens. Varieties either grow as a bush or as a vine (pole beans). Common bean originated in South and Central America but are globally grown today as an inexpensive protein source and for their nitrogen-fixing capabilities.

## Cooking with Green Beans...

### Three Bean Pasta Salad

This recipe from [Pulses.org](https://pulses.org) for three bean pasta salad features not only green beans but also chickpeas and kidney beans providing supercharged protein.

The pasta and beans are mixed with chopped red bell pepper and red onion, then tossed in a light dressing made

with dijon mustard, red wine vinegar, olive oil and fresh parsley.



[Get recipe here](#)

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### For More Information on the Feed the Future Innovation Lab for Legume Systems Research

[Visit our website](#)



This newsletter is made possible by the generous support of the American people through the United States Agency for International Development (USAID) under the Feed the Future initiative. The contents are the responsibility of Michigan State University and do not necessarily reflect the views of USAID or the United States Government.



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## FEED THE FUTURE INNOVATION LAB FOR LEGUME SYSTEMS RESEARCH

November 2022



The Feed the Future Innovation Lab for Legume Systems Research fosters dynamic, profitable, and environmentally sustainable approaches that contribute to resilience, productivity, and better nutrition and economic opportunities. The lab is managed by Michigan State University.

### *From the Management Office*

#### Legume Lab Project Supported Students Visit and Study at U.S. Universities



As part of institutional capacity-building efforts, the Feed the Future Innovation Lab for Legume Systems Research projects support international students to visit and study at U.S. universities.

**Maria Mazala**, a student from Zambia was awarded a scholarship from the NDSU collaborative project, *Genetic Improvement of Dry Beans for Bruchid Resistance for Southern Africa*. She is currently pursuing her master's degree in plant sciences at North Dakota State University (NDSU). Her advisor is Dr. Juan Osorno, NDSU professor and PI for the project.

Maria's research focuses on evaluating the agronomic performance of newly developed bruchid-resistant lines and contributing to the development of bruchid-resistant bean varieties through the identification and validation of molecular markers that can be used to select bruchid-resistance genes.



In 2021, Maria also received the John H. Longwell Jr. Memorial scholarship from the plant Science department. The award is given to an NDSU graduate student involved in the genetic improvement of agronomic crops (plant breeding).

Maria holds a bachelor's degree in plant science from the University of Zambia (UNZA). Prior to being enrolled at NDSU as a student, she was a research assistant for Dr. Kelvin Kamfwa at the UNZA Dry Bean Breeding program.

Becoming a plant breeder and traveling internationally has always been her dream. She is extremely grateful to have received the scholarship to study at NDSU. The opportunity has helped her to solidify her confidence to become the best version of herself. Her current research interests include plant breeding, molecular genetics, and statistics.

**Mr. Junior Bruno Papa Mbar Ndiaye** is a Native of Senegal, pursuing an MS degree in Sustainable Management of Horticultural Agroecosystems at the department of Animal Biology at Cheikh Anta Diop University, Dakar, Senegal. He has a BS degree in Agricultural Sciences – Crop Breeding and Genetics from the Agricultural and Rural Training High Institute, of the University of Thies, Senegal.

As research technician at the National Agricultural Research Center in Bambey, Junior had worked on different projects evaluating best management practices for upland rice production in in the southern Peanut Basin agro-ecological zone of Senegal.

Junior is one of the scholarship beneficiaries funded by the Legume Systems Innovation Lab. His research is focused on developing appropriate calibrating equations to predict nutritional quality of dual-purpose cowpea varieties using Near Infrared Spectroscopy (NIRS). The field research component of his MS studies were conducted at the Senegalese Agricultural Research Institute, at the National Center of Agricultural Research in Bambey, Senegal (over the 2021 growing season).

Currently, at the Kansas State University Agricultural Research Center- Hays (from April through December 30, 2022) he is getting hands on training sample processing and utilizing NIRS for forage quality analysis.

"With the help of my supervisors (Dr. Obour and Dr. Keith Harmony at Kansas State University), I have successfully established calibration equations that can be used predict forage nutritive value of dual-purpose cowpea samples brought from Senegal," shares Junior.

"I am currently writing my thesis and have gained significant experience in



dryland cropping systems and soil management research with the direct involvement in ongoing my research activities in Dr. Obour' s Soil Management lab. The analytical and research skills gained over the 9-month exchange program at Kansas State University have provided me with a considerable skill set in forage analysis using NIR and soil management expertise that will serve me well when I return to my home country."



**Adefemi Oluwadamilola Olubunmi** is a fourth-year Ph.D. student researcher in Agricultural Economics at the University of Ilorin, Nigeria, now at Michigan State University (MSU) as a Visiting Scholar.

As a researcher he is interested in research to build empirically based policy recommendations and implementation. Having carried out a number of research projects over the years, he is able to meticulously manage, monitor, and evaluate projects. He describes himself as a great communicator, a self-starter, and a lover of people who is motivated by challenging

situations.

He is working with MSU Professor Michael Olabisi as his advisor and Principal Lead Researcher on the Feed the Future Innovation Lab for Legume Systems Research project, *Mobile and Smartphone Technology Impacts on Rural Communities: A project work under Promoting Trade Integration in Regional Legume Markets with Mobile Technology*. When not buried in research work, he loves video games, exploring, and learning new things.

**Ashafa Salisu Sambo** is a third-year Ph.D. student of Agricultural Economics at the Department of Agricultural Economics and Extension/Center for Dryland Agriculture, Bayero University, Kano, Nigeria. His areas of research include agricultural financing, rural-urban migration, food security, agricultural value chains, and farmers' well-being.



As a Visiting Scholar at Michigan State University he is supported by the Feed the Future Innovation Lab for Legume Systems Research.

He is working with professor Michael Olabisi. Ashafa will be working on a titled, *Profit Margins in Grain Value Chains: Evidence from KasuwaGo Survey Respondents*. KasuwaGo is a mobile app that connects grain farmers and traders.

Ashafa enjoys reading, watching documentaries, and playing table tennis in his spare time.



Over 100 global legume researchers and stakeholders attended the two-day public forum virtual event in March which featured Legume Systems Innovation Lab project research updates.

Each month we will highlight a recorded presentation from one of these research projects.

This month we feature the project, "**Promoting Trade Integration in Regional Legume Markets with Mobile Technology.**" The project is led by Dr. Michael Olabisi, Michigan State University and works in Niger and Nigeria.

**Click on the image below to view the presentation on YouTube.**



The image is a YouTube video thumbnail. At the top left is the FEED THE FUTURE logo with the text 'The U.S. Government's Global Hunger & Food Security Initiative'. To the right is the text 'Innovation Lab for Legume Systems Research' and a small video inset showing a man. The main title in large white text on a blue background reads 'Promoting Trade Integration in Regional Legume Markets ...with Mobile Technology'. Below the title, it says 'Global Convening February 2022'. At the bottom left is the USAID logo with the text 'FROM THE AMERICAN PEOPLE'. At the bottom right is the MICHIGAN STATE UNIVERSITY logo.

## *In the Field*

### **Dual-Purpose Cowpea Varieties Provide Farmers a Win-Win in the Senegal Peanut Basin**



*Senegal farmer, Badara Diouf poses in his dual-purpose cowpea field trial.*



*Research project technicians taking agronomic data in Mr. Ousmane Mbacke's Baby trial within his 30 ha cowpea farm.*

Smallholder farmers in the Senegal peanut basin have been introduced to newer and improved dual-purpose cowpea varieties that offer both increased grain and fodder yield as well as fodder quality. These varieties can provide a win-win in the agropastoral farming systems across the peanut basin in Senegal.

Researchers from Kansas State University in collaboration with their counterparts at Senegalese Agricultural Research Institute (ISRA) recently demonstrated two dual-purpose cowpea varieties at several farmer field days. Farmers in attendance were so interested in trying the improved dual-purpose varieties, that several picked a handful of seeds from the fields to plant next year in their fields. The research project, *Sustainable Intensification of Dual-Purpose Cowpea Varieties for Enhanced Food and Fodder in Senegal* is a part of the Feed the Future Innovation Lab for Legume Systems Research managed by Michigan State University.

The dual-purpose cowpea varieties Leona and Thieye have stay-green property at maturity that increases fodder quality, an important trait for the region. In addition, the dual-purpose varieties are providing dual benefits as fodder yield averaged 255 kilograms per hectare (kg/ha) and grain yield averaged 256 kg/ha higher for the dual-purpose varieties as compared to the locally preferred variety Yacine. Priced at \$2.50 per kilogram, farmers are receiving \$640 per hectare more in income from grain yield gains alone.

Mr. Badara Diouf is a farmer in the village of Darou Salem, Senegal. Mr. Diouf participated in the on-farm trial in the 2021 growing season and choose to continue planting the dual-purpose cowpea varieties Leona and Thieye on his farm in 2022.

“The new cowpea varieties that were given to me last year perform better than ones we usually plant, they mature early too. For example, last year, with these new varieties [Leona and Thieye], I had greater grain yield, used some of it for food, shared some of it with neighbors and family, and had some seeds for this year planting,” says Badara of his experience with the dual-purpose varieties.

Mr. Ousmane Mbacke is a farmer and a Muslim community leader in Darou Mousty, Senegal. He participated in the on-farm trial in 2021. He was so pleased with results of the 2021 trial that he planted 30 hectares of his land to dual-purpose cowpea varieties in the 2022 growing season.

“So far, results we are getting from this variety trial and the genotype by management study on my farm are amazing. We have also seen the varieties produce greater fodder amounts in addition to increase grain yield. We would like to see these varieties disseminated throughout the region and to other cowpea farmers in Senegal,” explains Ousmane.

[Learn More](#)

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***In the News***

**Articles**

## Peer Reviewed Publication

Beye, A.; Diakhate, P.B.; Diouf, O.; Faye, A.; Obour, A.K.; Stewart, Z.P.; Assefa, Y.; Min, D.; Prasad, [P.V.V. Socio-Economic Constraints of Adopting New Cowpea Varieties in Three Agro-Ecological Zones in the Senegalese Peanut Basin](#). Sustainability 2022, 14, 14550.

## Featured Legume of the Month

### Adzuki Bean



Adzuki beans are a small reddish brown bean that is nutty in flavor and somewhat sweet. It is often used in Asian cuisine, and is particularly popular in Japanese recipes.

The bean is very high in dietary fiber, potassium, and a good source of protein. Other nutrients include iron, vitamin B6, magnesium, and calcium. Adzuki beans contain no cholesterol making them a heart healthy choice.

## Cooking with Adzuki Beans...

### Zenzai - Sweet Adzuki Soup

Zenzai soup is a sweet Japanese dessert. This recipe from [Pulses.org](#) includes a total of four ingredients including the adzuki beans, sugar, salt and rice cakes. It is served warm and a favorite on chilly evenings.

The adzuki beans are cleaned, boiled, mixed with the sugar and a pinch of salt, and topped with rice cakes.



[Get recipe here](#)

**For More Information on the  
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## FEED THE FUTURE INNOVATION LAB FOR LEGUME SYSTEMS RESEARCH

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December 2022



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*From the Management Office*

Happy Holidays



As we reflect on 2022 and look forward to 2023, the Legume Systems Innovation Lab is grateful for all the inspiring

researchers, students, colleagues, and friends we are fortunate to collaborate with.

Near or far, we wish you all a happy and healthy holiday season.

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## FEED THE FUTURE INNOVATION LAB FOR LEGUME SYSTEMS RESEARCH

January 2023



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### *From the Management Office*

#### Legume Lab to Host Researchers at Global Convening in Zambia



The Feed the Future Innovation Lab for Legume Systems Research is preparing to host over 100 participants during *Global Convening 2023*, which will be held as an in-person event in Livingstone, Zambia February 21-24.

The annual event provides global legume researchers and stakeholders an opportunity share project updates and engage in strategic conversations about the future of legume systems research. After two years of holding the event virtually, the Legume Systems Innovation Lab is looking forward to in-person interaction.

Look for highlights of the event next month in the February newsletter.

### GLOBAL VIRTUAL CONVENING 2022

Over 100 global legume researchers and stakeholders attended the two-day public forum virtual event in March of 2022 which featured Legume Systems Innovation Lab project research updates.



Each month in this newsletter we have been highlighting the video recording from one of our projects.

This month, as we prepare for Global Convening 2023, we feature presentations from the remaining three projects not yet highlighted.

**"Improving Incomes and Nutrition Security Development and Commercialization of Consumer Preferred Processed Legume-Based Products in Malawi and Zambia"** is led by Dr. Robert Fungo, Alliance of Bioversity International and CIAT. The project works in Malawi and Zambia.

**"Transforming Seed Systems to Respond to Bean Variety Demand Through Multi-Stakeholder Platforms in Malawi"** is led by Dr. Jean Claude Rubyogo, Alliance of Bioversity International and CIAT. The project works in Malawi.

**"Cowpea Atlas: Mapping Cowpea Data Sources and Gaps in West Africa"** is led by Dr. Ousmane Coulibaly, CERAAS/ISRA. The project works in Benin, Nigeria, Niger, and Senegal.

**Click on the images below to view the presentations on YouTube.**

Next month we will share highlights from our 2023 Global Convening to be held in Livingstone, Zambia. Read more about the 2023 event in the article above.



## *In the Field*

### **Empowering Sustainable Solutions: Changing the Narrative Through Capacity Development**

Kelvin Kamfwa grew up in a small-scale farming family in rural Zambia. As a youth he would often go into his family's cassava field and be discouraged by pests and diseases ravishing the field.

“It used to bother me, because that had serious repercussions, that you are not self-sufficient in terms of food for the rest of the year,” shares Kelvin. “I thought there must be a way to change this narrative.”

And change the narrative, Kelvin did. Determined to be a changemaker, Kamfwa earned his Bachelor of Science in Agricultural Sciences from the University of Zambia (UNZA). He continued his studies at Makerere University in Uganda where he earned a master’s degree. He then returned to UNZA where he lectured on crop science, his first step in making a difference in the lives of his fellow Zambians.

Knowing he had more to give, Kelvin once again left Zambia to pursue his Ph.D. in Plant Breeding, Genetics and Biotechnology at Michigan State University (MSU). His program was supported through the Feed the Future Innovation Lab for Collaborative Research on Grain Legumes, which also managed legume research in Zambia.

“My goal at MSU was to receive my Ph.D. in plant breeding and genetics so I could take those skills back to the people in Zambia,” says Kamfwa. “I wanted to make a career as a bean breeder. There is a need to increase the food production in my country.”

Today, Dr. Kelvin Kamfwa is a faculty plant breeder at UNZA. Through the Feed the Future Innovation Lab for Legume Systems Research project, *Genetic Improvement of Dry Beans for Bruchid Resistance for Southern Africa*, Kelvin collaborates with researchers from North Dakota State University (NDSU) to develop and introduce weevil resistant common bean varieties for Zambian farmers.

He also continues to support his community not only through his bean breeding research, but also through his commitment to develop the next generation of bean breeders. Kelvin currently mentors four students that are supported by the Legume Systems Innovation Lab project. Three students are working towards their master’s degree at UNZA and one student from UNZA is working towards her Ph.D. at NDSU.



*Kelvin Kamfwa pictured in the field on the campus of Michigan State University.*



*Bean bruchids bore holes into the beans, while the bruchid resistant beans pictured center are free of bruchid damage.*

Bean weevils are a post-harvest pest responsible for over 48% losses in

quality and quantity of common bean in storage. The UNZA Bean Breeding Program has developed multiple breeding populations for resistance to common bean weevil. Additionally, some of these breeding populations also have shown resistance to other economically-important pests and diseases, such as aphids, and are low soil fertility tolerant.

Kamfwa understands that breeders can not only develop a new or enhanced product, but they must develop one that is desirable and meets the needs of the community. In response, he and his colleagues have introduced gender-responsive tools into bean breeding. He shares this innovative approach as he works with early career researchers and students.

These activities will have direct economic impacts in the region not only by offering a new product that can be stored for longer periods of time without losing quality, but also by allowing households to store beans they can eat safely.

While Kelvin's ambition to seek solutions to the crop pests and diseases that plagued his childhood family farm has larger been realized, his continuing dedication to training future Zambian breeders will likely cast an even wider net for food security in Zambia.

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## *In the News*

### Senegalese Researcher Visits Legume Lab Office



*Aliou Diagne, pictured second from right, poses with MSU Ph.D. candidate and Legume Lab researcher Hanna Carlson (R), David DeYoung, Legume Lab Program Manager (L back), and MSU AFRE and Legume Lab researcher Veronique Theriault (L front).*



The Legume Systems Innovation Lab management team at Michigan State University (MSU) recently welcomed researcher Aliou Diagne, visiting from Senegal. Dr. Diagne currently works on the Legume Lab project, "**Quantifying the Scope and Scale of Nutritious Cowpea Products in Local Markets**" led by Veronique Theriault from MSU. The project, which works in Senegal and Mali aims to identify incentives for expanding the array of nutritious cowpea-based products sold in local markets, especially by small-scale women enterprises. Value-added cowpea-based products can provide more market opportunity for farmers while providing nutritious food options.

Aliou Diagne, Senegalese researcher with over 25 years of experience across sub-Saharan Africa. His research concentrates on agricultural development issues in sub-Saharan Africa including agricultural policies, value chains development, impact evaluation, technology adoption, microfinance and poverty analysis. Aliou graduated in 1994 from Michigan State University with a dual Ph.D. in Agricultural Economics and in Economics. Aliou has won numerous awards including AfricaRice Distinguished Service Award for Outstanding Service and Contribution to the Africa Rice Center (2014). He has served as associate editor for the journals: Food Security (2009 – 2015) and The African Journal of Agricultural and Resource Economics (2005 – 2012). He was also a member of the Scientific Committee of the National Fund for Agricultural Research and Innovation for Development (FONRID) of Burkina Faso (2012 to 2018).

Diagne is also committed to training the next generation of researchers. He currently mentors MSU Ph.D. student, Hanna Carlson who is a part of the Legume Lab supported project team. Hanna was awarded the Glenn & Sandy Johnson Fellowship from the MSU Department of Agricultural, Food, and Resource Economics (AFRE), which supports the visit of Dr. Diagne to mentor her on the research for one of her dissertation essays. While at MSU, Aliou will also lead a research seminar for AFRE.

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## *Featured Legume of the Month*

### COWPEA



Cowpea, also commonly known as black-eyed pea is an important source of affordable protein worldwide.

One cup of cooked cowpea is 198 calories and provides 13 grams of protein. The legume is also high in dietary fiber, iron, and magnesium.

Cowpea is resilient to drought prone climates and can be grown in marginal environments making it an important food and fodder crop in sub-saharan Africa.

### Cooking with Cowpea...

### Tapalapa Bread

Cowpea flour is a featured ingredient in tapalapa, a popular West African bread.

We found this recipe for tapalapa at [www.196flavors.com](http://www.196flavors.com). The recipe notes that, *tapalapa is made from a mixture of wheat and millet flour, to which is added maize flour, as well as cowpea flour. It resembles the French baguette from the outside but is somewhat different. It is heavy and dense with a crust and a taste that is reminiscent of the inside of soft pretzels.*



We look forward to giving it a try and hope you will too!

[Get recipe here](#)

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### *From the Management Office* Highlights from the Legume Systems Innovation Lab Global Convening in Livingstone, Zambia



The Feed the Future Innovation Lab for Legume Systems Research hosted over 120 participants during *Global Convening 2023*, which was held February 20-24 in Livingstone, Zambia.

The annual event provides global legume researchers and stakeholders an opportunity share project updates and engage in strategic conversations about the future of legume systems research.

During a gala awards dinner, several researchers were recognized by the Legume Systems Innovation Lab's Technical Management Advisory Committee (TMAC) for outstanding work in global legume systems research.

Recognized with the Meritorious Achievement Award was Dr. Bao-Lam Huynh of the University of California, Riverside.

The Early Career Grain Legume Scientist Award was presented to both Dr. Michael Olabisi from Michigan State University and Dr. Mamadou Sissoko from the Université des Sciences Sociales et de Gestion de Bamako in Mali.



The TMAC also presented the Meritorious Achievement Team Award to the project titled, "*Genetic Improvement of Dry Beans for Bruchid Resistance for Southern Africa*," led by Dr. Juan Osorno from North Dakota State University. The project also works with University of Zambia, Dept. of Agricultural Research and Technical Services (DARTS) in Malawi, the Instituto de Investigaç o Agraria de Mozambique (IIAM) in Mozambique, and the University of Nebraska.

Pictured below are the winners alongside TMAC members Robin Buruchara, Joyce Mulila-Mitti, Legume Lab Deputy Director John Medendorp, and Legume Lab Director Barry Pittendrigh.



Dr. Bao-Lam Huynh, University of California, Riverside receiving the Meritorious Achievement Researcher Award



Dr. Juan Osorno, North Dakota State University and team receiving the Meritorious Achievement Team Award



Dr. Michael Olabisi, Michigan State University receiving the Early Career Grain Legume Scientist Award



Dr. Mamadou Sissoko, Universit  des Sciences Sociales et de Gestion de Bamako - Mali receiving the Early Career Grain Legume Scientist Award

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## *In the Field*

### **New Project Designed to Transform the Nepal Lentil Sector**

The Feed the Future Innovation Lab for Legume Systems Research recently launched a new project designed to transform the Nepal lentil sector. The



project is supported through funding provided by USAID Nepal.

Lentil is an important crop in Nepal for nutrition, soil health, and as both a staple and export commodity. However, crop yields have become stagnant with the low productivity attributed mainly to stressed environmental conditions and agronomic practices. Lentil produces compete with imports as large legume processors prefer imported lentil due to cost and uniformity. Lentils occupy 60% of the total grain legume area and production in Nepal, making the country the sixth largest producer and fifth largest exporter of lentils. Given that lentil demand has expanded 6.2% over the past ten years, it is estimated that Nepal's revenue from lentil export could double or even triple if relevant actions are taken to boost cultivated area, productivity, and market integration.

Nepal lentil is among the most nutrient dense in the world however many of the these nutritionally rich varieties do not possess the stress and disease tolerant traits for higher yield potentials. Research indicates that the average age of commercialized lentil varieties is 27 years and that 85% of small holder farmers use seed that is decades old. One goal of the project is to identify varieties that are stress resistant, nutritionally biofortified, high yielding, and consumer preferred and provide strategies for farmer variety adoption.

The project will also identify low-cost, low-barrier easily adjustable farming practice solutions and deployment strategies that are expected to lead to increased yields, decreased pest and disease damage, and reduction of post-harvest loss. The solutions will be delivered through a "curriculum" for lentil farming developed in conjunction with national agricultural extension agencies. These best practices will be deconstructed into easy-to-follow steps and visualized in animations created by Scientific Animations Without Borders (SAWBO). Scientific Animations Without Borders (SAWBO) is a Purdue university-based program that transforms extension information into 2D, 2.5D and 3D animations, which are then voice overlaid into a diversity of languages.

Approximately 10 videos will be created or adapted from the existing SAWBO library to address such topics as agronomy, integrated pest and disease management, processing, and post-harvest loss. The animations which will be available in multiple language variants will be disseminated through social media platforms and a network of all value chain actors and their networks. The videos are projected to reach approximately 670,000 farmers.

A closer look into the Nepal lentil seed and market systems will also identify bottlenecks and weak points from seed/variety availability from the producer level all the way through to legume market and export. A special focus will be made on the varietal nutritional panels and potential advantage for nutrition fortified varieties, especially taking advantage of the increase presence of selenium in the lentil of Nepal. Multi-variety trials will be conducted to ensure selected varieties respond to localized trait and preference requirements.

To address these issues the project will organize two or three multi-stakeholder platforms (MSP). MSPs provide "spaces" for learning and knowledge exchange where various stakeholders come together to diagnose their challenges and identify opportunities to address them that are mutually benefiting. The project will build upon existing networks to organize the MSPs.

A focus of the project is to address the capacity development of women. Due

to the feminization of agriculture in Nepal, since 2016 women have made up more than 50% of the agricultural workforce. The project will be gender responsive and engage with gender specialist to facilitate the inclusion across all activities with a special emphasis on women's access to seed.

USAID/Nepal's development goal is a more self-reliant, prosperous, and inclusive Nepal that delivers improved democratic governance and health and education outcomes. More specifically, this project addresses the four strategies USAID/Nepal has identified for obtaining this goal. The strategies are to engage the private sector in agricultural value chains, promote value chain growth and diversification, increase incomes, and enhance food security. This is being achieved by focusing on five value chains, namely, vegetables, rice, maize, lentils, and goats.



*The project will focus on capacity development of women and be gender responsive across all project activities.*

## ***Featured Legume of the Month***

### **COMMON BEAN**



Common bean, as all legumes, are a nutritious and healthy diet addition. They have high protein content and generous amounts of fiber.

A single one cup serving provides at least half of the U.S. Department of Agriculture's recommended daily allowance for folic acid, which is particularly important for pregnant women. Common bean also supplies 25-30 percent of the recommended levels of iron and 25 percent of magnesium.

Common beans are grown worldwide and are important in global food security.

## Cooking with Common Bean...

# Vegan Green Bean Casserole with Creamy Chickpea Sauce

Common green beans are very versatile as side and main dishes. We love this vegan recipe from [Pulses.org](https://pulses.org) that combines green common bean and chickpeas.

The green beans and chickpeas are combined with onions, garlic, salt, pepper, rosemary, and balsamic vinegar. The casserole is baked and topped with hazelnuts. Give it a try for a meatless Monday!



[Get recipe here](#)

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March 2023



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### *From the Management Office*

#### Legume Systems Innovation Lab Partners with Media Company dedicated to Zambian Youth Empowerment

The Feed the Future Innovation Lab for Legume Systems Research has teamed up with Zambian media house, Chibolya Media Farm to produce several videos highlighting the program's research in Zambia and Malawi.

Chibolya Media Farm is an initiative of Every Moment Connections, a full service media agency based in Lusaka. The initiative is focused on youth empowerment and skills transfer targeting the disenfranchised Chibolya, Zambia area.

Chibolya, which is located approximately 35 kilometers from the capitol of Lusaka, experiences high crime, unemployment, extreme poverty, and gender-based violence. Youth from this challenging environment are brought into the filmmaking program and taught all aspects of the industry including scriptwriting, editing, camera operations, producing, editing, and marketing. After an intensive training the students are then provided an internship with industry leaders to further hone their skills. Several graduates of the program are now fully employed in the industry.

The first video shoot took place on the University of Zambia (UNZA) campus and highlights the program's dedication to building the capacity of the next generation of legume researchers. The video features three generations of global legume researchers supported through USAID funding to earn their advanced academic agricultural degrees.



Dr. Juan Osorno is currently a plant breeder at North Dakota State University. He received degree training at the University of Puerto Rico under the USAID Dry Grain Pulses Collaborative Research Program (Pulse CRSP) program led by Michigan State University. Juan currently leads the Legume Lab project working on bruchid-resistant common bean varieties for Southern Africa.

Leading the project work in Zambia is Dr. Kelvin Kamfwa. Kelvin, a Zambian native, received his PhD in plant breeding from Michigan State University which was supported by the Feed the Future Innovation Lab for Collaborative Research on Grain Legumes. After graduation Kelvin returned to Zambia and now leads the bean breeding lab located at the University of Zambia.

The Feed the Future Innovation Lab for Legume Systems research is also supporting the advanced degrees of four future legume researchers. Modreen Chinji from Zambia, Isabel Mugovo from Mozambique, and Rebecca Thole from Malawi are studying for their Masters degree at UNZA and working in Dr. Kamfwa's lab. Zambian, Maria Mazala is currently studying for her Master's degree at North Dakota State University under Dr. Osorno.

The photo shoot at UNZA brought all six of these current and future global legume researchers together to share their experiences and how integral the Legume Systems Innovation Lab has been in their journeys.

The Legume Lab is partnering with Chibolya Media Farm on this and other project videos in Zambia and Malawi. Chibolya Media Farm is an initiative of Every Moment Connections, a full service media agency based in Lusaka. The initiative is focused on youth empowerment and skills transfer targeting the disenfranchised Chibolya, Zambia area.

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*Juan Osorno, North Dakota State University, is prepped for his video segment shot at the UNZA seed store where hundreds of bean varieties are stored.*



*Maria Mazala is a Masters Degree student from Zambia studying at North Dakota State University. She is pictured here in the UNZA bean breeding greenhouse.*



*The entire Chibolya Media Farm crew and Legume Lab team celebrate the wrap of a long day of video shooting and production.*

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## ***In the Field***

### **Getting Lifeline Through Improved Bean Variety**

by Yohane Chideya

Even though she has been farming beans for many years, raking yields season-in-season-out, Esther Jere was still not satisfied. Her yields were never enough for her family of six to make ends meet.

Today, the middle-aged farmer from Emfeni area in Malawi's northern region district of Mzimba is no longer the same.

After being selected under the Multi-Stakeholder Project (MSP) as one of the demonstration farmers for the new NUA45 variety bean seeds, she has seen her yields more than triple.

This was after the Alliance of Bioversity International & CIAT provided the Catholic Development Commission (CADECOM) in Malawi with NUA45 bean seeds to be used for demonstration plots, with Mzimba district being among the districts that was selected to be part of the initiative.

"I got one kilogram of NUA45 variety of beans from CADECOM through CIAT. This is NUA45 type of beans. After planting, I ended up harvesting 18 kilograms. I reserved five kilograms as seeds and used the rest. After replanting, I have harvested 60 kilograms.

My life has really changed for the better. NUA45 is by far much better than other varieties we used to plant in the past, because this variety is giving us [farmers] bumper yields," explains Jere.

This, she says, was the case despite planting the variety in summer season, a



period where the country receives little or no rainfall.

### **Bean farming as a game-changer**

Researchers under the MSP ascertain that the NUA45 cultivar, that has a yield potential of 2.9 tonnes per hectare, has been widely adapted since it was released on the market regionally in Malawi, Swaziland, Zambia and Zimbabwe.

Similarly, experts are of the view that common bean could be crucial to Malawi's food security and poverty reduction, as cultivation of improved varieties could be a real game-changer. Studies have shown that smallholder farmers have limited scope to generate cash but their venture in legume production may offer a valuable source of income.

However, these farmers face challenges accessing improved variety and certified seeds.



*Esther Jere, a bean farmer in Malawi's Mzimba District has enjoyed success in growing a new bean variety provided through the multi-stakeholder platform she has joined. Photo courtesy of Eunice Magwaya.*

### **Concerted efforts**

Upon realizing that there was low production and accessibility of improved bean varieties, different stakeholders proposed a joint collaboration for increased production of prebasic, basic and certified seed, for improved and more beneficial bean business in the country.

Because of this, the players in the MSP agreed to intensify seed production of other bean varieties and decided that this be guided by market demand. Established in 2019 through the bean corridor approach, the platform seeks to respond to bean variety demand through MSPs, with funding from USAID through the Feed the Future Innovation Lab for Legume Systems Research at Michigan State University.

Grain traders on the other hand, have been partnering with farmers in the platform and supporting them to access quality seed of improved varieties through soft loans.

Milele Agro-Processors and Afriseed are the two companies that have

supported farmers with seed of the haricot bean variety through loans. Since then, farmers have been able to access quality seed of the right variety which was not possible before.

Operations Manager for Milele Agro-processors, Ngale Phekani says through this approach, they would like to meet the requirements of the markets in terms of volumes and quality.

“We are targeting an export market and the market we have is unique; it has specific demands and these can only be met through quality seed,” says Phekani.

Furthermore, to address the increased demand for the certified bean seeds, one of local seed production companies, Seed Co Malawi pledged to produce 40 metric tons of NUA45 prebasic seed which will see the company producing 800 metric tons of certified seed in 2023 alone.

Consequently, the platform has opened bean grain market opportunities through market linkages such that offtakers have secured grain market offer of 10,000 metric tons.

This has excited grain offtakers, including Managing Director for Afriseed Grace Mijiga Mhango, who is also President for the Grain Traders Association of Malawi.

She says they have intensified recruitment of bean growers in the country’s production hubs to reap off from the market opportunities.

“The Multi-Stakeholder Platform is unique market led business model that has recognized participation of private sector as key to sustained markets and broadens the market base for bean commodities,” says Mhango.

### **MSP’s future prospects**

Following the impact that the MSP has had on farmers in recent months and the enormous potential that it has to improve bean farming in Malawi and neighboring countries, different players are impressed with the strides the project has made within a shortest time possible.

During project support mission visit, after noting what had been accomplished within the shortest period of time, one of the members of the platform Barry Robertson says there is need to capitalize on the opportunities for continued growth.

“The Multi-Stakeholder Platform is a very interesting and exciting investment. It is a profoundly logical approach in order to understand what are the challenges and opportunities in the system that are going to effect real change.

“By linking producers with those that are buying, processing, moving things in the value chain; we realize this is a logical model moving forward,” he explains. Barry’s sentiments are also echoed by platform members and they are looking forward to a sustainable and more impactful platform.

Moving forward a number of activities have been aligned to maximize the benefits of the platform. This include recruiting other key value chain actors

such as agricultural inputs dealers and putting in a place private sector-based platform steering committee.

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## Featured Legume of the Month

### BEAN FLOUR



A recent blog featured on California Beans [website](#) explains how you can make your own bean flour.

Bean flours are naturally gluten free and high in protein. You can use it as a substitute for all-purpose flour in both baking and cooking. There are many great bean flour recipes on the internet - so search for a favorite and give bean flour a try!

### Cooking with Bean Flour...

#### Speckled Chocolate Chip Cookies

We found this recipe for speckled chocolate chip cookies from [Pulses.org](#) that uses bean flour in place of traditional all-purpose flour.

The recipe calls for black bean flour, but as noted any whole bean flour will work. However, you may not get the speckled effect if using other varieties of bean flour. We suggest trying the recipe using different bean flours to see which is your family's favorite!



[Get recipe here](#)

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April 2023



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### *From the Management Office*

## Legume Systems Innovation Lab Brings Together Nepal's Lentil Value Chain to Explore How Multi-Stakeholder Platforms Can Transform the Sector

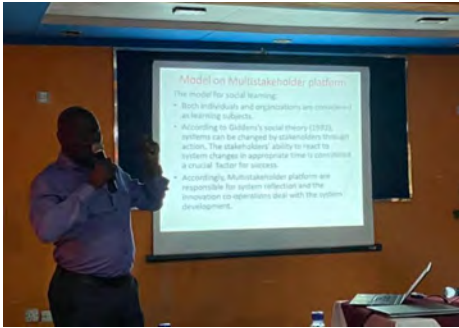
The Feed the Future Innovation Lab for Legume Systems Research recently held three regional lentil value chain stakeholder workshops in Nepal. The purpose of these workshops was for attendees to understand what multi-stakeholder platforms (MSPs) are and to decide if they are needed for Lentil in Nepal, and if so, to begin developing plans to form a MSP in their province.

"By connecting value chain actors, farmers should receive better prices and processors should obtain the quantity and quality of grain demanded. Also, the diverse actors will collectively explain to policy makers why current policies impacting the lentil value chain should be changed and previous reactionary policies should not be repeated," explains David DeYoung, Legume Systems Innovation Lab Program Manager. "The diverse stakeholders represented at the meeting all agreed on the need for establishing a MSP and an interim committee was formed to convene the next meeting, identify priorities, and plan next steps for MSPs."

Lentils occupy 60% of the total grain legume area and production in Nepal, making Nepal the sixth largest producer and the fifth largest exporter of lentils. Given that lentil demand has expanded 6.2% over the past ten years, it is estimated that Nepal's revenue from lentil export could [double or even triple if relevant actions are taken to boost cultivated area, productivity, and market integration.](#)



Workshops were held in the Nepalese cities of Dhangadi, Nepalgunj, and Bardibas which represent the main growing regions of the country. The project is supported by the USAID Nepal Mission.



*Eliud Barachi researcher with Alliance Bioversity and CIAT explains how multi-stakeholder platforms work and impact the bean sector in Malawi.*



*Participants ask questions during the two-day event held in Dhangadi. The workshops were funded by USAID Nepal mission and will help identify weaknesses in the lentil value chain and potential solutions.*



*Attendees of the multi-stakeholder platform workshop in engage in interactive discussions on the Nepal lentil sector.*

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## ***In the Field***

### **Exploring the Potential of Bean-Based Products through Public-Private Partnerships and Multi-Stakeholder Platforms in Malawi and Zambia**

by Justice Munthali, Robert Fungo, Smith Nkhata, Vincent Nyau, Mwiinga Muluube, Kennedy Muimui, Virginia Chisale, Patricia Onyango, Janet Fierro, Mark Thompson, Fannie Gondwe, Mesther Juwa, Mwai Kukada, Winani Chiwowo and Jean Claude Rubyogo

Malawi and Zambia have shared history and culture, including diet patterns. In



terms of common beans consumption, people in both countries consume the beans, mostly as relish, by boiling the beans (fresh or dry) and eating it alongside a starchy paste known as nsima, usually made from maize. Beyond mere boiling and at times seasoning, minimal value-addition exists locally resulting in fewer varieties of bean-based products on the markets.

Recent findings from a study about improving quality and safety of bean-based products through market-led and multi-stakeholder models in Malawi and Zambia, found that adding value to beans through processing has potential to improve consumption and utilization. Further, from the same study, comparatively, Zambia was observed to have a wider variety of bean-based processed foods, including dried precooked, frozen precooked and blended flours. In addition, Zambia was found to have more traded volumes of bean-based food products in regular markets than Malawi.

The study is part of the Feed the Future Innovation Lab for Legume Systems Research project titled **“Improving incomes and nutrition security through development and commercialization of consumer preferred processed legume-based products in Malawi and Zambia.”**

Enhancing consumption of beans in the diet is beneficial in the two countries as they are affordable, easy to grow, locally acceptable and highly nutritious. Despite the numerous benefits of bean-based foods, they have not yet reached their full potential. A few selected processors have managed to get their bean-processed products, majorly precooked beans, on the shelves of supermarkets in Malawi and Zambia.

In Malawi, Sun Fresh Africa is a female and youth owned start-up which has managed to expand her products into the South African supermarket chain Shoprite. In Zambia, Don Products and Trinity Super Foods have also mainstreamed their precooked bean products in Shoprite and Games supermarkets.

However, the supermarkets in the two countries are still generally flooded with imported processed products like canned beans. In addition, many challenges have crippled the bean-based products industry, including lack of infrastructure and support for the production and commercialization of these products; inadequate investment in product development resulting in limited diversity; lack of market intelligence information in terms of demand, willingness to pay and preferences; and inadequate awareness about the processed bean-based products.



**Supa Beans** are from **Don Products** based in Lusaka, Lilongwe, Malawi based Lusaka-based company Zambia offers both precooked red **SunFresh** Africa offer

Trinity Super Foods and white beans in shelf stable frozen precooked beans who offers beans pouches that can be quickly that are fully cooked and packaged in sealed reheated. These offer consumers a can be easily reheated by pouches. This product quick and convenient way to busy consumers looking for reduces the cooking incorporate high protein beans into a quick and nutritious meal time of beans to just 10 busy family schedules. option. minutes.

The Legume Lab project is geared to address most bottlenecks pinpointed above. The research-based project takes the market-oriented approach to provide market information on the demand of value-added legume-based products, strengthen linkages amongst stakeholders, test promising products and processing technologies, and catalyze commercialization.

The project lays the groundwork for commercialization of legume-based processed products in Malawi and Zambia by improving understanding of demand for these products. Further, the multi-stakeholder nature of the project enables engagement with critical stakeholders, such as the national bureau of standards, who play a key role in enhancing the capacity building of processors in food safety, processing, and certification.

In addition, the safety and health benefits of bean-based foods and their demand and acceptability are being tested and improved through the project. Thirteen bean-based prototypes were developed and tested, all of which received above average sensory scores in panelist tasting evaluations. The positive results indicate that these products have potential for market acceptability. Two processors, one in Malawi and one Zambia, were selected for further optimization of the prototypes. The processors, along with project supported university students are optimizing the processing procedures necessary to develop shelf-stable legume-based products of these prototypes. These procedures include: optimal ingredient formulation; process flow; process conditions; consumer acceptability; cost of production; food safety; volume of production; nutrient content; shelf stability and regulatory conformation following the product development ladder.

As a result of this project we will have a diverse range of bean-based products giving consumers a variety of safe and nutritious products to choose from. The development and commercialization of bean-based products also has the potential to create income for micro, small and medium enterprises, as well as smallholder farmers in these countries. In addition, the increased demand for bean-based products will stimulate the growth of local processing industries, thereby, creating more jobs and further contributing to economic growth. Furthermore, most products are gender and environmental friendly with their linkages to saving time and energy.

In conclusion, with the right support and investment, the market for these products could expand even further, leading to a brighter future for these countries and their people.

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***Featured Legume of the Month***

**CHICKPEAS**



April 22 is National Chickpea Day in the U.S. Here at the Legume Lab we think chickpeas should be celebrated more than just once a year!

Chickpeas, also known as garbanzo beans, are a great protein source providing 39 grams of protein per cup! A one cup serving also provides needed fiber and 50% of potassium of the USDA's recommended daily allowance of this nutrient.

Given their high protein content, chickpeas provide a great choice for vegetarian and vegan diets. They are versatile and easy to incorporate into a variety of recipes from snacks to main courses.

## Cooking with Chickpeas...

### Chickpea Museli Matcha Squares

Traditional muesli, or *museli* as it is called in this recipe, combines oats with a variety of seeds, dried fruits, and spices then bakes them til crunchy. It is often enjoyed for breakfast or as a healthy snack.



**Chickpea Museli Matcha Squares** incorporate pumpkin, sunflower, and chia seeds with coconut, dried fruit, matcha powder, salt, and cinnamon into rolled oats. The mixture is then baked after which, combined with canned chickpeas, almond butter, brown rice syrup, honey, and coconut oil. The mixture is then frozen til firm.

The final result is a crunchy and satisfying protein packed snack great after a workout or sports.

[Get recipe here](#)

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## FEED THE FUTURE INNOVATION LAB FOR LEGUME SYSTEMS RESEARCH

May 2023



The Feed the Future Innovation Lab for Legume Systems Research fosters dynamic, profitable, and environmentally sustainable approaches that contribute to resilience, productivity, and better nutrition and economic opportunities. The lab is managed by Michigan State University.

### *From the Management Office*

## Legume Systems Innovation Lab Associate Award, SAWBO RAPID Featured During Innovation Lab Site Visit in Kenya



The Innovation Lab Council Directors Meeting held recently in Nairobi, Kenya provided the Legume Systems Innovation Lab an opportunity to showcase SAWBO RAPID, an associate award of the program, during a site visit to a Murang'a County farm.

Scientific Animations Without Borders (SAWBO) is a university-based program, currently at Purdue, which uses a systems approach to transform research innovations on key topics such as agronomics, pest management, and post-harvest storage into animations that are translated into a diversity of languages from around the world and disseminated globally.

Feed the Future SAWBO Responsive Adaptive Participatory Information Dissemination Scaling Program (RAPID) was awarded to the Legume Systems Innovation Lab to create and disseminate SAWBO animations designed to mitigate the secondary effects of COVID-19.

In addition to the SAWBO *RAPID* animations on reducing post-harvest loss by storing legumes in air tight jerrycans and how to store sweet potato roots after harvest to create planting vines at the onset of the rains, the visit featured seven other SAWBO animations which educate farmers and communities on easy to deploy innovations using locally sourced materials.

The visit was attended by, members of SAWBO management, the Legume Systems Innovation Lab as well as leadership from other Feed the Future Innovation Labs, USAID Washington, USAID Missions from across the African region, and CGIAR centers. The visit also welcomed local honored guests and the community to participate in the event.

Kataru Concepts SAWBO volunteers, based in Kenya, participated by demonstrating technologies featured in SAWBO animations which they work to deploy to farmers and communities in their networks throughout Kenya.

The SAWBO library contains over 150 animations in over 300 languages and dialects. The videos have reached over 50 million people in 130+ countries. The award winning program has measurable impact through peer reviewed research with over 50 published articles. Learn more by visiting the SAWBO [website](#).



*SAWBO volunteer demonstrates how to save up to half of firewood and charcoal simply by adding rocks and a grate to cooking fires. This technique is featured in the SAWBO animation titled, *How to Reduce Firewood and Fuel in Cooking: Using Rocks and a Grate*.*



*The visit was held on the family farm of Mwalimu Swaleh in Murang'a County, Kenya. Mwalimu (above left) explains how he learned to scout for fall armyworm in his maize field and then demonstrated the process. Mwalimu learned this technique by watching the SAWBO animation titled, *How to Indentify and Scout for Fall Armyworm* in Swahili language.*





*James Kamuye Kataru (far right) introduces his team of SAWBO volunteers who traveled from across Kenya to participate in the event.*

## *In the Field*

### Legume Lab Projects Begin Close-Out Meetings

As the Legume Systems Innovation Labs begins to wind down program activities many of the projects are holding close-out meetings to share their successes.

One project led by Robert Fungo from Alliance Bioversity/CIAT titled **“Improving incomes and nutrition security through development and commercialization of consumer preferred processed legume-based products in Malawi and Zambia”** recently held their close-out meeting in Lusaka, Zambia.

The project which worked to support the development of legume-based agro-processing operations through understanding factors that drive and constrain the demand for nutrient rich legumes, as well as identifying relevant interventions to alleviate these constraints, in Malawi and Zambia enjoyed many accomplishments during a very short project period of just 18 months.

Advanced degrees for six students were supported by the project at the University of Zambia (UNZA) and the Lilongwe University of Agriculture and Natural Resources (LUANAR). The research led by these students was integral in understanding the existing market, consumer awareness and demand for processed bean products, safe product formulations and nutritional content, product optimization, and product traits most important to consumers.

The students presented their research findings during the closeout meeting which was attended by project management, academia, government, bean stakeholders, and private sector bean processors from both Malawi and Zambia.

Food processors shared how the data generated and workshops held by the

project assisted to bring them together for collaboration and learning which will strength the market segment as well as the individual private sector companies.



*Attendees of the Legume Systems Innovation Lab project, “Improving incomes and nutrition security through development and commercialization of consumer preferred processed legume-based products in Malawi and Zambia” close-out meeting in Lusaka, Zambia*

## ***Featured Legume of the Month***

### **BAMBARA BEANS**



Many outside of Africa may never heard of the bambara bean. This legume grows underground and is often called bambara groundnut, earth pea, or njugo bean.

Bambaras grow well in dry areas and in poor soil. They are drought tolerant and are nitrogen fixing making them a good choice for crop rotation. West Africa produces about half the world's crop, often grown by women for consumption in the home.

[Recent studies have found it is high in protein and a complete food, providing all of the daily nutritional requirements for protein, carbohydrate and fat/oil of an adult human.](#)

Seeds can be many different colors from cream to red to black-eyed and variants in between. Early varieties can be harvested in as little as 50 days while other varieties maturing in up to 100 days. The greens of the plant are often used for livestock fodder.

## **Cooking with Bambara Beans...**

### **Creamy Bambara Beans**

Bambara beans can be eaten fresh or soaked and boiled after being dried.

This recipe for **Creamy Bambara Beans**

from [Juliet@biscuitsandladles](#) uses dried bambara beans and flavorful ingredients like shrimp powder, scotch bonnet peppers, and ground grain of paradise to make a tasty and satisfying dish that can be served as a side or main feature.



[Get recipe here](#)

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[Visit our website](#)



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## FEED THE FUTURE INNOVATION LAB FOR LEGUME SYSTEMS RESEARCH

June 2023



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### *From the Management Office*

#### Legume Lab Project Builds Capacity at the University of Zambia



The Legume Lab project, "**Genetic Improvement of Dried Beans for Bruchid Resistance for Southern Africa**" has recently installed two Mattson cookers at the University of Zambia in Lusaka.

Long cooking times is a major constraint in the consumption of protein rich beans. The addition of the Mattson cookers will allow the project to easily research cooking times of the different common bean varieties they are developing.

The research team led by North Dakota State University is working to release bean varieties that are resistant to bruchids and have reduced cooking times.

Bruchids are a post-harvest pest responsible for over 48% of bean losses in quality and quantity of common bean in storage. The new varieties which offer both the reduced cooking times and bruchid resistance are expected to be welcomed by small holder farmers throughout the Zambian bean growing regions.

[Learn More](#)

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## *In the Field*

### Legume Lab Project Close-Out Meeting Held in Malawi

Members of the Legume Lab project titled, "**Transforming Seed Systems to Respond to Bean Variety Demand Through Multistakeholder Platforms in Malawi**" recently convened in Lilongwe to discuss project outcomes as formal activities come to a close.

The project addressed the lack of coordination among legume value chain stakeholders in Malawi and introduced multistakeholder platforms as a means of linking researchers, seed companies, farmers, and private sector grain offtakers.

Through these platforms every member of the value chain benefits. Researchers receive critical information directly from farmers and offtakers on what variety traits are important and desired, seed companies benefit by understanding what varieties of seed the farmers and offtakers will support and purchase, farmers benefit through relationships with grain offtakers which can lead to growing agreements and support in adopting good agricultural practices, and offtakers benefit through the availability of quality legume products demanded by their customers.

The project was led by the Alliance Bioversity/CIAT which worked to bring the value chain players together by providing the framework for the relationships to grow. Even though project activities are coming to a close, the multistakeholder platforms are expected to continue providing sustainable solutions for the legume value chain in Malawi.



*Attendees of the Legume Systems Innovation Lab project, "Transforming Seed Systems to Respond to Bean Variety Demand Through Multistakeholder Platforms in Malawi" close-out meeting in Lilongwe, Malawi.*

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## *Featured Legume of the Month*

**LENTILS**



[Lentils.org](http://Lentils.org) is a great resource for all things lentils. Some of the interesting things we found out about lentils on this website include:

- When lentils are combined with a whole grain they can provide the same quality protein as meat.
- A half cup of cooked green lentils provides 32% of your daily recommended allowance of fiber.
- Canada is the world's leading producer and exporter of lentils.

Lentils come in a variety of colors. Brown is the most common but you may also find green, yellow, orange or red in your local supermarket. Each have different cooking and other characteristics but all offer excellent nutritional benefits for you and your family.

## Cooking with Lentils...

### Thai Lentil Larb

Larb is a popular Thai salad that is usually made with pork, chicken or other meat proteins. This recipe for **Thai lentil larb** from [Pulses.org](http://Pulses.org) uses lentil as the main protein making this a great option for your meatless Monday dinner.



Light and flavorful, lentil larb is best served on lettuce and eaten by hand. Best of all this recipe takes less than 30 minutes to get on the table leaving more time for other activities or a quick meal during a busy day.

[Get recipe here](#)

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## FEED THE FUTURE INNOVATION LAB FOR LEGUME SYSTEMS RESEARCH

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July 2023



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### *From the Management Office*

## Legume Systems Innovation Lab Releases Semi-Annual Report



The Feed the Future Innovation Lab for Legume Systems Research Semi-Annual Report detailing activity from October 1, 2022 through March 31, 2023 is now available at this [link](#).

Feed the Future Innovation Lab for  
Legume Systems Research

Semi-Annual Report  
October 1, 2022 – March 31, 2023

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### *In the Field*

## Legume Lab Project Hosts Lentil Multistakeholder Platform Workshop in Nepalgunj, Nepal



Nepal lentil stakeholders from Madhesh, Sudurpashchim, and Lumbini provinces recently convened in Nepalgunj to discuss progress and next steps for the three lentil multistakeholder platforms (MSPs) formed a few months prior. Stakeholders from across the lentil value chain were represented at the three-day event which was led by the Feed the Future Innovation Lab for Legume Systems Research project titled, **"Transforming the Lentil Sector In Nepal."** The project is led by Michigan State University.

Lentil production in Nepal has decreased as many farmers have turned to planting more profitable crops. However, the demand for lentil, which is consumed daily in Nepal, remains high. In order to meet demand for affordable and quality lentil, processors have turned to importing the legume from such countries as Canada. The project is working to revitalize the Nepal lentil sector through connecting farmers, millers, processors, offtakers, researchers, agribusiness, and government in MSPs where each set of stakeholders can openly share their needs, form alliances, and collaborate to meet consumer demand. These public/private partnerships are expected to increase lentil production in Nepal to meet the increased demand for Nepali lentil.

The project also works to increase the knowledge of lentil farmers through an educational intervention program which features 15 animated videos on topics from lentil grain storage, good agricultural practices, finance, and women's empowerment. The animations have been produced in conjunction with project partner, [Scientific Animations Without Borders](#) (SAWBO), which is based at Purdue University. The animations which are available in eight Nepali languages will be deployed through the MSP partners, collaborators, and through social media platforms and broadcast TV.

[Learn More](#)

## Reflections from Nepal Lentil Multistakeholder Platform Workshop Participants



*“Seeds must be of good quality and farmers are in need of that. From what I see based on my dealing with farmers in buying their lentil is that they need trainings and support in things like processing which can help them increase their prices. MSP can be that platform where farmers can be connected to trainings.”*

Indira Acharya, Miller, Radha Krishna Rice Mill, Kailali



*“First, we need to raise awareness among farmers to produce musuro (lentils). We need to introduce mixed cropping like lentil goes well with mustard so in case of calamities at least one crop will grow and it will be a win-win situation for all. The MSP can help push this process and we as cooperatives can take them to the farmers”*

Padam Raj Rijal, Kailali, Board member of Small farmer Agri cooperative limited, Kailali



*“For production, we want to promote the seed producers and connect them with the farmers through the MSP platform. Then as cooperatives, we can buy the lentils of these farmers by guaranteeing them so their livelihood is secure.”*

Yuvraj Sharma, Chairperson, Singhabahini Shivashakti Farmers Cooperative, Bardiya

## **Featured Legume of the Month**

### **COMMON BEANS**



Common beans are a good source of protein, dietary fiber and minerals. This low cost nutritional powerhouse is grown throughout the world and is an important crop for food security.

The beans, when dried and stored properly, can be kept for long periods. Young pods can be cooked and consumed fresh. Dried or fresh common beans provide good nutrition at an affordable price.

### **Cooking with Common Beans...**

#### **Green Bean and Mushroom Medley**



Green beans are a great addition to vegetable side dishes.

This colorful recipe for **Green Bean and Mushroom Medley** is found on the [myplate.gov](http://myplate.gov) website. It features green beans, mushrooms, carrots and onions sautéed in olive oil then seasoned with lemon pepper and garlic salt and topped with toasted slivered almonds.

Pair this recipe with grilled salmon or chicken and you have a delicious and nutritious meal for the whole family.



[Get recipe here](#)

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## FEED THE FUTURE INNOVATION LAB FOR LEGUME SYSTEMS RESEARCH

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August 2023



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### SAVE THE DATE

**Legume Systems Innovation Lab Close-Out Meeting**  
Tuesday August 29 10:00am - Noon Eastern Time

[Register](#)

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### *From the Management Office*

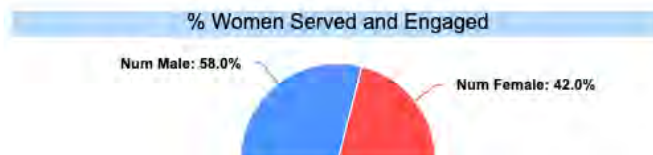
#### **Legume Systems Innovation Lab Program Nears End**

As the Feed the Future Innovation Lab for Legume Systems Research nears its program end date of August 2023, we reflect on our milestones and accomplishments.

Over our five-year program, the Legume Systems Innovation Lab executed six initial activity projects, seven competitive projects, five commissioned projects, two Mission buy-ins, and one associate award. We also implemented a science communication and grant writing seed grant competition and provided support to projects on cross cutting themes of gender, youth, nutrition, resilience, and capacity development.

Key metrics to date include degree training for 63 individuals and short-term trainings to over 6,200. The Legume Systems Innovation Lab has engaged 49 institutional partners in 13 countries and engaging 100 researchers with 32 technologies.

# Legume Systems Innovation Lab Key Metrics



We are excited by the progress we have made in global legume systems and hope to continue this important work. Please visit our [website](#) for final program closeout technical reports and as a resource for continued legume research in West and Southern Africa.

Don't miss our program close-out meeting on Tuesday, August 29 from 10:00am - Noon Eastern Time. Register at this [link](#).



*Maria Mazala from Zambia was one of the 63 degree trained legume researchers supported by the Legume Systems Innovation Lab. Maria previously studied under project PI Kelvin Kamfwa at the University of Zambia and was mentored by collaborating project PI Juan Osorno at North Dakota State University where she earned her Masters degree in Plant Sciences supported by the lab.*



*The Legume Systems Innovation Lab Management Entity in Washington D.C. during the Innovation Lab Congressional Reception hosted by Michigan State University. The reception provided an opportunity to showcase the important work of the Legume Lab and the impact of U.S. research and development funds on building self reliance and resilient neighbors abroad.*



*It seems like only yesterday... the first Legume Systems Innovation Lab Global Convening held in Saly, Senegal set the stage for a systems approach to legume research.*

## *In the Field*

### Legume Lab Project Close-Out Meetings

As the Legume Systems Innovation Labs begins to wind down program activities many of the projects are holding close-out meetings to share their successes.

A project led by Veronique Theriault titled, **“Quantifying the Scale and Scope of Nutritious Cowpea Products in Local Markets of West Africa”** recently held dissemination workshops in Mali and Senegal.

West Africa is the global locus of cowpea production. Yet, little is known in quantitative terms about the scale and scope of cowpea products supplied in local markets and demanded by households. Our research in Mali and Senegal has contributed to closing the information gap by building a quantitative inventory of cowpea products supplied locally and consumed by urban and rural households. In each country, key findings were presented to a diverse group of stakeholders during dissemination workshops organized by Dr. Mamadou Sissoko in Bamako, Mali, and Dr. Aliou Diagne in Thies, Senegal.

In both countries, the participants learned and discussed the opportunities and constraints in processing, selling, and consuming cowpea-based products, such as sho-froufrou, accra, and fari, in Mali and ndambe and akara in Senegal. At both workshops, processors were invited to display their processed cowpea products, and participants were offered cowpea-based products at lunch to their delight.

In Mali, the quality of the presentations given by the graduate students was noticed and appreciated as demonstrated by the testimony of one of the participants: “ I want to congratulate the students for speaking so eloquently. I was positively surprised to see them present with confidence. It shows that



they were well-mentored.”

In Senegal, the presentations were followed by a fruitful discussion on how to better integrate cowpea-based products into school canteen menus. The two close-out workshops were a success, with stakeholders engaged and committed to further developing the cowpea value chains.



*Participants of the Legume Systems Innovation Lab project, “Quantifying the Scale and Scope of Nutritious Cowpea Products in Local Markets of West Africa” dissemination workshop in Bamako, Mali*

## **Reflections**

### **Muddy Hands, Mighty Voices**

By Sony K.C.

“Early dawn, I wake up a farmer and dirty my hands and feet in my muddy farm. During dusk, I sleep a farmer with a vision that these muddy hands and a day long perseverance will reap utmost benefits. There are many women like me who sacrifice their soul in the farms but their contribution goes unrecognized,” stated Laxmi Bohora, a lentil farmer from Lumbini province.

“We would never have learnt more about ourselves [women] if we were not invited to this multistakeholders platform, today. Most of the time we just do what comes without honoring ourselves and our capabilities,” opined Indira Acharya, a miller of lentils amongst other producers.

These testimonies came during an interview as part of a multistakeholder platform (MSP) workshop held in Lumbini province between 19th and 21st July, 2023. This platform is an initiation of the Feed the Future Innovation Lab for Legume Systems Research led by Michigan State University to connect the value chain actors in lentil production and marketing. Laxmi’s audacious statement gives me hope, as someone who works to address the issues of gender equity and social inclusion (GESI), that women’s unrecognized roles in

the increased feminization trend of agriculture, can be recognized through right support and platform.

As these women were reflecting their life along with few other women, myriad of thoughts crossed my mind, thinking, social change involving women and their progress is still a dream for my country. I went into flashbacks, 15 days before the MSP happened, when I was dialing lentil farmers of Lumbini Province, trying to get the GESI balances on participation through my invitation. Reaching out to these farmers through the list we created beforehand was an ordeal expedition. First, as I called, about a dozen of women received their calls with children crying on their arms, or background, giving a hint that it would be close to impossible for them to travel for the MSP workshop. Few women handed over the calls to their husbands, who showed no interest in sending their women to the workshop providing multifarious reasons as “these platforms come and go but no one will help farmers,” “who will do household work if women are gone,” “it is time for us to plant paddy now,” “this is the wrong time for farmers to attend as it is planting season,” et cetera.

In retrospect, of the many calls made, very few women decided to trust me and my team and made it to the workshop. For this, I had to reach out to them every day for about six days so I wouldn't lose the loop. These women represented Brahmin, Chhetri and Janjati (Tharu) castes, though my intention was to make it more inclusive, I remained content. The most important and a turning point for me was hearing from them that they had never ever been invited to a platform like this. And if they had a chance, they would have reached their highest potentials as farmers. As the only miller, Acharya, who represented the platform, evidently, there are more men in the marketing of lentils or any other crop in our country, Acharya's one voice as a miller gives thousand pictures about the situation of women who work beyond farms.





*Samjhana Shahi, Laxmi Karki Bohora, Jugmani Tharu, and Ichhya Chaudhary are smallholder lentil farmers from the Lumbini province of Nepal*

Additionally, their stories of becoming lentil farmers or millers, their struggles in juggling between home and farms, their rise by becoming a part of cooperative, learning and unlearning through each other and trainings was not only great for the ears but also gave insights to make the platform more inclusive through better leadership and support within the MSP committees.

As main objective of the MSP has been to create a momentum between various stakeholders engaged in *musuro* (a type of lentil) farming as producers, seed suppliers, technical supporters, institutional supporters, holistically, those engaged in the lentil value chain, the importance of GESI seemed evident. This is because we were successful in creating a connection between multifarious stakeholders from various age, caste, background and status. Additionally, without inclusive approach, we will only under shadow our human capital who are women from various ethnic groups and culture. It is also evident from my experience that women, in particular can voice their concerns if they have a platform as opposed to society deciding that women cannot speak or bargain from their side. All these require platform that allows them to freely express their concerns away from their muddy farms.

I came home with a big relief learning from these mighty women whose stories are powerful than it ever can be, whose contributions are extraordinary in the agriculture sector and who need a pinch of support to improve their livelihoods through lentil farming.



*Indira Acharya is a Nepal lentil miller*



*Dr. Sony K.C., Gender Equity and Social Inclusion (GESI) expert, Nepal*

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## ***Featured Legume of the Month***

### **COWPEA**

Cowpea is a highly nutritious crop important for food security in many parts of Sub-Saharan Africa. The pods can be eaten prior to maturity providing food during the "hunger gap" (time between when food from the previous years planting runs out and when food from the



current crop is harvested) and the plants are also used as livestock fodder.

Naturally high in protein, low in fat, and affordable, cowpea has been referred to as "poor man's meat." Cowpea tends to be drought tolerant and can grow in poor soil conditions making it a crop of choice among smallholder subsistence farmers.

## Cooking with Cowpea Flour...

### Cowpea Flour Soup

In less than 30 minutes you can make an easy and tasty cowpea flour soup with fish.

Begin by combining tomatoes, onions, bouillon and seasonings to make a stock. Then mix cowpea flour with water and blend into the stock by stirring briskly.

Lastly, prepare your fish and add to the soup. Cook 10-15 minutes and season generously. Enjoy!



[Get recipe here](#)

## For More Information on the Feed the Future Innovation Lab for Legume Systems Research

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## FEED THE FUTURE INNOVATION LAB FOR LEGUME SYSTEMS RESEARCH

September 2023



### LEGUME SYSTEMS INNOVATION LAB ANNOUNCES PHASE TWO FUNDING

#### **Global Legume Systems Research Program Receives Extension to Expand Reach and Impact**

The Feed the Future Innovation Lab for Legume Systems Research led by Michigan State University has received a five-year funding extension which will also extend the program to into new geographic regions. The program which currently works in West and Southern Africa will expand into the Great Lakes/East Africa and Central America/Caribbean regions. Cowpea and common bean are the Legume Systems Innovation Lab focus crops.

Legumes are a nutrient-dense staple crop that have multifunctional roles in smallholder farm systems in developing countries including food and nutrition security, generating income, providing livestock feed and fodder, contributing to the sustainability of soil systems through their nitrogen-fixing capabilities, and aid to mitigate the impacts of climate change as low greenhouse gas emitting crops.

During the five-year extended period of performance, the Legume Systems Innovation Lab will pursue four key focus crop objectives which include 1) best agronomic practices and services, 2) inclusive inputs and market systems, 3) targeted varietal scaling and development, and 4) climate change adaptation and mitigation.

The Legume Systems Innovation Lab, which uses a unique systems approach, will implement Regional Stakeholder Convenings (RSC) to identify gaps in the current legume systems to drive new activities. “The RSCs will bring together legume stakeholders to determine how efficiently and effectively the existing systems deliver food security for smallholder farmers and commercial products to consumers in a specific region,” shares Barry Pittendrigh, Legume Systems Innovation Lab Program Director. “This approach will help us to identify new focus areas to lead innovative interventions and fill the gaps. This may extend



or expand the work of previous projects or in some cases be new interventions.”

These interventions could include new technologies, scaling of existing technologies, data to drive decision making, or knowledge products for significant impact. Pittendrigh describes these activities as, “research for development.”

To assist the Lab, a Technical Leadership Team (TLT) will be formed to represent four key system functions of the program which include 1) seed systems and varietal development, 2) value chains and system integration, 3) climate change and resilience, and 4) gender, equity, and social inclusion. The TLT will serve as advisors in their area of expertise to help guide activities and led support to projects.



To ensure scaling, a core strategy of the program’s market systems approach will be the integration of multi-stakeholder platforms (MSPs). MSPs provide “spaces” for learning and knowledge exchange where various stakeholders come together to diagnose their challenges and identify opportunities to address them that are mutually benefiting. MSPs have been used extensively and successfully in more developed economies to create networks among actors in value chains. These take the form of commissions, associations, councils, and confederations, among other labels intended to identify them as coalition building efforts. They are inclusive in the way that they bring



stakeholders together, sometimes narrowing their focus to represent sub-groups of value chain actors. In emerging economies, where institutionalism is less developed, such coalitions are often informal or absent.

“Every project within our program will integrate an MSP approach to ensure efforts are well interwoven into the demand driven value chain for immediate uptake into systems that are focused on inclusivity, effectiveness, and efficiency,” explains Legume Systems Innovation Lab Deputy Director John Medendorp. “MSPs are a cornerstone of the Lab’s legume system transformation strategy.”

Stakeholder engagement will then take place through the MSPs, both at the regional level and at the local/project level. As part of the stakeholder engagement, the Lab will especially engage the non-governmental organizations, commercial sectors, and the international donor community through the platforms but also through the Legume Industry Consultative Committee (LINCC), an advisory board of private sector partners that view international actors as potential collaborators.

Anticipated key results of the extended work include inclusive and sustainable agriculture-led economic growth, strengthened resilience among people and systems, and a well-nourished population, especially among women and children.

Also, cross-cutting intermediate result goals and objectives for the Legume Systems Innovation Lab include improved climate risk and other natural resource management, gender equality and female empowerment, increased youth empowerment and livelihoods, more effective governance, policy and institutions, and improved human, organizational and system performance.



Highlights of the first five years of the Legume Systems Innovation Lab include 32 technologies developed, 63 individuals granted higher education degrees, and over 6,200 educated through short-term trainings. The Lab engaged in 30 research and development projects in 13 countries involving over 100 researchers from 51 institutional partners. Gender data indicates 42% of those engaged in Legume Systems Innovation Lab activities were women.

The Feed the Future Innovation Lab for Legume Systems Research is funded through [Feed the Future](#), the U.S. Government's global hunger and food security initiative led by the United States Agency for International Development (USAID). The Legume Systems Innovation Lab was awarded to Michigan State University in 2018, the extended performance period will continue the work of the Lab through August 2028 with an anticipated total funding of up to \$35 million.

Michigan State University has a long history of investments in global legume research and development spanning over 40 years.

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