Feed the Future Innovation Lab for Soybean Value Chain Research

Title Page

Management Entity Information:
University of Illinois at Urbana-Champaign (UIUC)

Technical and/or Advisory Committee Information:
SIL has an Advisory Board of 9 individuals from the U.S. and Africa representing the public and private sectors with expertise in international soybean development and research; private sector and higher education investment and collaboration; and human and institutional capacity building.

- Dr. Ken Dashiell, Deputy Director General for Partnerships and Capacity Building, International Institute for Tropical Agriculture
- Dr. Brady Deaton, Chancellor Emeritus, University of Missouri
- Dr. Robert Easter, President Emeritus, University of Illinois
- Dr. Dan Gustafson, Deputy Director-General, Operations, Food and Agricultural Organization
- Dr. Mark Keenum, President, Mississippi State University
- Dr. Earl Kellogg, Senior Fellow, Association of Public and Land Grant Universities
- Dr. Marc Linit, Associate Dean for Research and Extension, College of Agriculture, Food and Natural Resources, University of Missouri
- Dr. Paul Rose, Owner, Sossi Company, Kenya
- Dr. Abdulai Salifu, Former Director General, Council for Scientific and Industrial Research, Ghana

Map or List of Countries Where the Project Works
Please see below list of countries where we work.

List of Program Partners*
In addition to SIL’s direct collaboration with its core partners in its 5 project countries, the lab has expanded its network and services to additional practitioner groups engaged in soybean development. A comprehensive list of program partners to-date is reflected below.

- U.S.: COB; MU; MSU; UMES; UGA; USDA/ARS; WFP
- Ghana: AA Pure Soy Milk Factory; ACDI/VOCA; CRS; CSIR-FRI; CSIR-SARI; Green-Ef Eco Business Village; IFDC; IITA; Jaksally; MEDA; MOFA/Ghana; Omya International; RING; SADA; SFSA; SPRING; UDS; USAID/Ghana; WACCI
- Cote d’Ivoire: CDI
- Ethiopia: JARC; EIAR; EthioChicken; Hilna Enriched Foods; SFSA; TechnoServe; USDA/FAS
- Indonesia: SFSA
- Kenya: Greenspec Ltd.; SFSA
- Malawi: IITA; LUANAR
- Mali: SFSA
- Mozambique: Association Pala Wassokoti; GAIN; IIAM; IITA; USAID/Mozambique; Winnua Ltd.
- Nigeria: COB; IITA
- Rwanda: CDI; SFSA
- Switzerland: SFSA
- Zambia: IITA; Syngenta; SFSA; ZamSeed
- Zimbabwe: Seed Co Ltd.; SFSA; USAID/Zimbabwe

* U.S. partners (e.g., universities, private sector, USDA) and international partners by country.
Acronyms:

**ACDI/VOCA**  Agricultural Cooperative Development International/Volunteers in Overseas Cooperative Assistance

**BASF**  Clinton Development Initiative

**CGIAR**  Consortium of International Agricultural Research Centers

**COB**  Church of the Brethren

**CRS**  Catholic Relief Services

**CSIR**  Council for Scientific and Industrial Research

**EIAR**  Ethiopian Institute of Agricultural Research

**FRI**  Food Research Institute

**GAIN**  Global Alliance for Improved Nutrition

**GHS**  Ghana Health Services

**GCP**  Generation Challenge Programme

**IBP**  Integrated Breeding Platform

**IFDC**  International Fertilizer Development Centre

**IIAM**  Mozambique Institute of Agricultural Research

**IITA**  International Institute of Tropical Agriculture

**IT**  Information Technology

**JARC**  Jimma Agricultural Research Center

**LUANAR**  Lilongwe University of Agriculture and Natural Resources

**MRA**  Managed Research Area

**MEDA**  Mennonite Economic Development Associates

**MOFA**  Ministry of Agriculture

**MS**  Master of Science

**MSU**  Mississippi State University

**MU**  University of Missouri

**NARS**  National Agricultural Research System

**NGO**  Non-Governmental Organization

**RING**  Resiliency in Northern Ghana

**SADA**  Savannah Accelerated Development Authority

**SARI**  Savanna Agricultural Research Institute

**SFSA**  Syngenta Foundation for Sustainable Agriculture

**SIL**  Feed the Future Innovation Lab for Soybean Value Chain Research (Soybean Innovation Lab)

**SMART**  Soybean Management with Appropriate Research & Technology

**SUNS**  Soybean Uptake & Network Survey

**SSA**  Sub-Saharan Africa

**TIF**  Tamale Implement Factory

**UDS**  University for Development Studies

**UGA**  University of Georgia

**UGL**  University of Ghana Legon

**UIUC**  University of Illinois at Urbana-Champaign

**UMES**  University of Maryland Eastern Shore

**USAID**  United States Agency for International Development

**USDA/ARS**  United States Department of Agriculture Agricultural Research Service

**USDA-FAS**  United States Department of Agriculture Foreign Agriculture Service
Executive Summary

In this Executive Summary we focus on new and burgeoning activities, while activities noted in previous annual reports continue on track. In Ethiopia, Ghana, Mozambique, Malawi and Zambia SIL researchers collaborate with the NARS system of Africa (EIAR, SARI, JARC, IITA) to transform the soybean plant breeding system in SSA. Recently work has expanded to Mali, Indonesia, Pakistan, Zimbabwe, Kenya, Rwanda, and Cote d’Ivoire. Specifically, SIL and its partner the Syngenta Foundation for Sustainable Agriculture have established a Pan African Variety trial program with local partners in the above countries. The trial program reflects a strategy designed to quickly bring farmers the best performing seed. SIL has successfully put under trial in Ghana new low processing and low P lines from their research plots in Costa Rica. SIL now also has under trial in Ethiopia new low phosphorous soybeans designed to perform well in tropical soils. In collaboration with SIL, year one of IITA’s soybean breeding has now begun in the new international soybean research station in Lusaka, Zambia.

SIL-supported Plant Breeding & Genetics M.S. degree program internships in the United States were successfully completed in the summer of 2016. Students conducted experiments and interacted with research managers in both the private and public sectors. Collaboration has begun with the University of Agriculture, Faisalabad, Pakistan as soybean 50 lines have been introduced into the national program and a joint conference on plant breeding was held.

The third year of SIL agronomic research trials at the Soybean Management with Appropriate Research and Technology (SMART) Farm in northern Ghana was successfully completed. Trials were expanded to include unique studies of seed population, which is so important given low seed germination levels and the importance of reducing labor and chemicals for weeding. Collaborations were begun with the MEDA organization to bring agronomic extension to the 821 communities and 20,000 women farmers in the program and living in the Upper West region of Ghana. Program officers from the United States, Nigeria, and Liberia came to learn how to bring soybean agronomics to their agricultural development strategy. A second annual Soybean Kickoff, a field day showing soybean agronomics, new varieties, and soy food, was held in the Upper West City of Wa before 140 farmers, industry representatives, and policy makers.

SIL recognized the challenge of accessibility to small scale mechanization and followed through with a novel thresher design contest and training program. SIL and its collaborators from the private sector and the Savannah Agricultural Research Institute have created the first locally produced and low cost (<$1k) soybean thresher that is village scale. SIL has also begun working with USAID contractors and the private sector to commercialize its soybean success kits for mass distribution across the northern regions of Ghana.

SIL has completed its second round of replicated surveys in Mozambique and Ghana. Following the baseline in year 1, these studies focus in on soybean uptake and smallholder experiences with the new crop. SIL, in collaboration with LUANAR, the agricultural university of Malawi will begin a novel aquaculture industry center. The Center is funded by the World Bank. SIL’s Soybean Dairy Entrepreneurship Network continues to grow and flourish as this year saw members start to benchmark their operations, participate in a webinar on packaging, and lead Ghana’s first Soybean Food Bazaar, attended by 200 chefs, policymakers, and food entrepreneurs.

Consistent with the institutional feeding focus of the Soy Food Bazaar, SIL has begun a study of orange flesh sweet potato supplemented with soy flour. This nutritionally improved weaning food is adapted to the Ghanaian diet and Ghana’s post-natal education and supplemental food program. Finally, SIL initiated household soy utilization trainings in Mozambique to support farmers who had
received soybean success kits. The question under study was whether complementing production technical support with training on integrating soy ingredients into the local cuisine would better sustain soybean adoption.

II) **Program Activities and Highlights†**

- SIL completed 3 years of soybean breeding efforts in Ghana and Ethiopia and 2 years of soybean breeding activities Zambia focused on crossing SIL-introduced diverse germplasm with locally-adapted varieties to develop new experimental lines; conducting yield tests of early and medium/late maturing lines; testing new sources of germplasm for disease resistance; and determining the persistence of Bradyrhizobium strains in Ghanaian and Ethiopian soils.
- SIL mentors and trains its African research leads at the West, East and Southern Africa breeding hubs on data collection, research trial management, and equipment use.
- SIL identified the influence of certain genes of interest (characterized maturity genes: E1, E2, E3, and E4; the long juvenile trait, and stem architecture) on soybean adaptation in an effort to control season length and improve yield compared with current African varieties.
- SIL improved soybean processing for household and livestock utilization through the development and identification of five low processing lines and evaluating of their performance in Ghana.
- SIL developed soybean germplasm that uses and acquires P efficiently under low soil P availability by selecting promising lines based on root characteristics and P concentration in the tissue. The performance of these lines are currently being evaluated in Ethiopia.
- SIL created a module specific to soybean in the IBP that supports soybean breeders in crop improvement activities (phenotypic evaluation and deployment of marker-assisted selection).
- The first student cohort enrolled in SIL’s Master’s in Plant Breeding & Genetics degree program at WACCI. The cohort worked in seed companies and research labs for a 6-week internship in the U.S.
- 3 years of agronomic research data have been produced by the SIL SMART Farm in the Northern, Upper East, and Upper West regions of Ghana. Findings include soil analyses; seed germination tests; nutrient amendment trials; variety trials; planting date trials; and plant population trials. The SMART Farm also serves as a hub for conducting extension programming on effective soybean production and for pesticide use training for practitioner groups.
- SIL & SFSA established the first Pan-African soybean varietal trial program to bring commercially-available soybean varieties to smallholder farmers through transparent, third-party testing. To-date the program is underway in 3 countries (Kenya, Malawi, Mali) with 6 additional countries entering the program in 2017 (Ethiopia, Ghana, Indonesia, Rwanda, Uganda, Zimbabwe).
- SIL designed a low-cost, locally-produced crop thresher to respond to the need for appropriate-scale harvest technologies. The design was based off the winner of SIL’s thresher design contest that was held among several U.S. and Ghanaian universities. SIL implemented an 8-day training with 12 local blacksmiths in Ghana to train on thresher fabrication and business and marketing activities. 3 threshers produced were distributed to 3 villages in northern Ghana to be studied for efficiency, ease of use and throughput.
- SIL conducted intensive village-level trainings and hands-on workshops in Mozambique on soy processing, soy nutrition and soy in local recipes to increase soybean utilization in the household.
- SIL started the first soy dairy entrepreneur network to improve the management and long term sustainability of enterprises by connecting and enabling entrepreneurs globally to share experiences, business practices, and technical knowledge. SIL provides the network training on packaging solutions, product development, business planning, marketing, branding, and more.

† Summary of program activities for the year, no more than one page in length.
• SIL human nutrition leads at SARI implemented sensitization, training and participatory demonstrations on producing local dishes with soybean; producing soymilk and tofu; and soybean nutritional and health benefits with 386 smallholder farmers in 17 communities in northern Ghana and among 1,096 students and staff from local schools as well as a sensory evaluation of soymilk.

• SIL is addressing the “first 1,000” days by developing a soy-based complementary food product also utilizing orange-flesh sweet potato. The feasibility and acceptability of the product is being tested in 4 villages in Ghana with 170 mother-infant pairs using questionnaires and focus groups.

• SIL hosted 2 consecutive years of the Soybean Kick-off Event in Ghana (October 2015 & 2016), showcasing the integration of research and development to place in farmers’ hands the latest high yielding varieties and the best agronomic prescriptions to ensure profitability for Ghanaian farmers.

• SIL hosted the first-ever Soy Food Bazaar in Ghana, a soy food industry event bringing together producers, suppliers, and manufacturers with customers, institutional buyers, and retailers to build connections across the long soybean value chain and bring new technical knowledge to the industry to help it grow and flourish. The event attended by 200 chefs, policy makers, and food industry members featured 20 industry booths, 3 technical panels, soy food tasting and a soy lunch.

• SIL released the first findings from the WEAI+ study in Mozambique and Ghana, highlighting important gender disparities in soybean uptake, input utilization, extension access and seed access.

• SIL launched the SUNS in Mozambique and Ghana, the first controlled research study addressing issues of technology adoption and drivers for adoption, value chains and the role of credit and savings, crop and utilization budgets, and gender equity and the role of women.

• SIL assisted SARI to install seed lab, irrigation, and IT infrastructure, improving the quality and efficiency of the breeding programs and connecting SARI with research partners worldwide.

• SIL provided the Church of the Brethren international technical team with training to bring SIL’s SMART farm technology to COB operations in Nigeria and Liberia.

• SIL established the research protocols, partnerships, and lab capacity to conduct experiments on the interplay between crop intensification and water quality.

• SIL is the first Innovation Lab to implement a SIL Gender Responsive Agricultural Development Assessment–Wave I (SIL GRADA-I), an online survey for persons in organizations affiliated with the Soybean Innovation Lab in the US and abroad (e.g., our project researchers and implementing partners) in an effort to assess the gender balance and representation of the SIL project itself.
Feed the Future Innovation Lab for Soybean Value Chain Research

III) Key Accomplishments‡

- 81 crosses in Ghana; 260 crosses in Malawi, Nigeria & Zambia; 156 crosses in Ethiopia
- 46 lines tested for yield in Ghana; 40 in Ethiopia; 51 in Malawi
- 134 rust lines evaluated in Ghana; 116 in Ethiopia
- 6 fungicide treatments on 3 varieties evaluated in Ethiopia
- 5 inoculum strains on 6 varieties evaluated in Ethiopia
- 705 attendees at SARI field days at planting and maturity stages (488 female)
- 1,900kg of breeder seed produced at SARI of 3 varieties
- 3 African soybean breeding partners mentored and trained on breeding program management, structure, output and on IBP tool
- 2 African soybean breeding partners admitted to African Plant Breeding Academy Class II
- 360 experimental lines created with varying allelic combinations individually controlling the genes of interest (characterized maturity genes: E1, E2, E3, and E4; the long juvenile trait, and stem architecture). Testing these lines over 2 years in 4 locations in Ghana.
- 5 low-processing soybean lines identified to improve household and livestock utilization
- 5 students enrolled in SIL’s Master’s in Plant Breeding & Genetics degree program at WACCI
- 6 courses identified to fill critical gaps in WACCI’s graduate curriculum as SIL MS program is added
- 2 years of course delivery in conjunction with WACCI faculty and topic expert/instructor
- 15 PhD and 5 MS students trained in Statistics I; 16 PhD and 5 MS students trained in Molecular Marker Analysis; 2 new WACCI faculty interfaced to teach next course offering; 21 PhD students received Plant Breeding module
- 3 years of SMART Farm data produced
- 7 agronomic research trials conducted at SMART Farm
- 10 varieties in variety test; 5 varieties in Phosphorous/Inoculum trial; 15 varieties in germination trial; 5 varieties in planting date trial; 5 varieties in plant population trial; 3 locations for soil testing; 30 years of weather data
- 3 countries engaged in Pan-African varietal trial program, 6 new countries starting in 2017
- 12 blacksmiths trained on low-cost, locally-produced thresher fabrication
- 4,800 SSKs distributed in Mozambique and Ghana to serve as instruments for WEAI & SUNS studies
- 8,000 people received soybean agronomic training on planting date, row spacing, plant population, seed germination, inoculation, fertilizer application, harvesting, storing
- 150 lead women farmers from MEDA organization trained in Quality Seed Production (affecting 10,000 female soybean growers)
- 156 people trained on soy processing, soy nutrition and soy in local recipes to increase soybean utilization in the household in Mozambique
- 170 mother-infant pairs enrolled in soy-based complementary food product study in Ghana
- 20 members representing 6 countries (Ghana, Benin, Ethiopia, Mozambique, Argentina, Columbia) engaged in Soy Dairy Entrepreneur Network
- 340 attendees to 2015 & 2016 Soybean Kick-off Events in Ghana
- 200 attendees to 2016 Soy Food Bazaar in Ghana
- 884 participants in 9 villages in Central and Northern Mozambique participated in WEAI+ study

‡ Concise statement of achievements, linked to relevant section of annual workplan and Performance Management Plan, limited to one page in length that focuses on outputs, not process, such as Feed the Future indicators and distillation of program achievements across all program activities. Reporting on numbers of project meetings is not an output. Include how it links to the Performance Management Plan.
• 675 participants in 9 villages in Ghana’s Northern Region participated in the WEAI+ study
• 834 participants in 4 districts in Ghana’s Northern Region participated in the SUNS study
• 8 in-person SIL events (Soybean Kick-off Event; Soy Food Bazaar; Crop Intensification in the Tropics WFP Side Event; Soybean Expansion in the Tropics AAEA Event; etc.) and 7 virtual SIL events attracting over 700 in-person attendees and 400 virtual attendees
IV) **Research Program Overview and Structure**

The mission of SIL is to provide soybean technical knowledge and innovation to directly support practitioners engaged in soybean production in the tropics. Practitioner groups include researchers, private sector firms, non-governmental organizations, extensionists, agronomists, technicians and farmer associations tasked with soybean development. SIL focuses its efforts on four key research pillars that comprise the essential components of sustained production, improved utilization and sustainable market linkages for soybean development:

- **Pillar I: Genetic Improvement**
- **Pillar II: Crop Productivity and Quality**
- **Pillar III: Nutrition**
- **Pillar IV: Value Chains & Socio-Economic Research**

To accomplish this mission SIL brings together leading U.S. and African soybean researchers, both natural and social scientists, to provide a sound research foundation to achieve the development to commercialization process of soybean in sub-Saharan Africa (SSA). SIL’s approach is to listen and understand the needs of soybean practitioners, then design activities that provide the answers that lead to success. Our technical experts cross the entire soybean value chain from germplasm management, seed systems and agronomic practice to storage, processing, nutrition, and value chain economics.

The SIL is comprised of strong natural and social science research that is fundamental to soybean development. The concept of a research foundation is meant to symbolize, as well as literally serve as, the basis on which the soybean development to commercialization process can go forward. The research and learning outputs, such as germplasm development, plant breeder training, inoculum investigation, agronomic guidelines, and characteristics of economically sustainable soybean production, provide organizations along the value chain the critical information needed for investment, decision-making, and enterprise development.

The SIL is based on an integrated modular design that maximizes collaboration among consortium members and stakeholders with the SMART Farm as its platform. The modularity allows specific programs to be expanded, extended, and replicated in other regions and countries and provides the flexibility needed in order to adapt to in-country needs according to each country’s current levels of soybean breeding, education, production, utilization, market development, and equitable access. All the modules play an important role in understanding the drivers of a sustainable soybean system.

SIL comprises four foundation pillars of activity. SIL researchers focus on nine Managed Research Areas (MRAs), led by the PIs at the primary SIL institutions the University of Illinois, University of Missouri, Mississippi State University and the University of Georgia:

- **MRA 1 Plant Breeding and Germplasm:** Brian Diers and Randy Nelson, University of Illinois
- **MRA 2 Grain and Seed Quality:** Kristin Bilyeu and Kerry Clark, University of Missouri
- **MRA 3 Production and Agronomy:** Dan Reynolds and George Awuni, Mississippi State University
- **MRA 4 Plant Breeder Education:** Rita Mumm, University of Illinois
- **MRA 5 Utilization for Human Nutrition:** Juan Andrade and Margaret Cornelius, University of Illinois
- **MRA 6 Utilization for Livestock Nutrition:** Mike Lacy, University of Georgia
- **MRA 7 Gender Impacts:** Kathleen Ragsdale and Mary Read-Wahidi, Mississippi State University
- **MRA 8 Economic Impacts:** Jill Findeis, University of Missouri
- **MRA 9 Environmental Impacts:** Jeremy Guest, University of Illinois
- **MRA 10 Seed Systems:** Dennis Thompson, University of Illinois
V) **Research Project Report**

a) **Objective 1: Genetic Improvement**

i) **Description:** SIL works to increase the soybean breeding capacity in its target countries by expanding the genetic base of soybean breeding to increase the rate of the yield improvement; conducting yield testing; testing new sources of germplasm for disease resistance; introducing and evaluating additional sets of lines to augment the gene pool; establishing hybridisation and inbreeding program to develop new soybean lines for traits including earliness, high yield, resistance to pod-shattering, biological nitrogen fixation, disease and pest resistance/tolerance, drought resistance/tolerance, etc.; making soybean crosses and developing new experimental lines from crosses that were made previously; inbreeding populations to develop new soybean lines; determining the persistence of non-native, effective Bradyrhizobium strains when inoculated into African soils; and increasing the capacity, effectiveness and, sustainability of soybean breeding programs through mentorship, training and education.

SIL is developing low processing, low latitude-adapted soybean varieties and has developed soybean germplasm that uses and acquires P efficiency under low soil P availability. SIL also engages with the CGIAR GCP’s IBP to create a soybean-specific module to support project breeders in crop improvement activities including phenotypic evaluation and deployment of marker-assisted selection. SIL developed the region’s leading Master’s Program in Plant Breeding at the UGL/WACCI to increase the pool of quality-trained individuals to manage African soybean research programs. SIL’s Pan-African soybean varietal trial program provides transparent testing of commercially-available varieties to identify new varieties from other countries/regions for smallholder farmers.

ii) **Collaborators:** UIUC: Brian Diers, Randy Nelson, Glen Hartman, Rita Mumm; MU: Kristin Bilyeu, Felix Fritschi, Carrie Miranda, Andrew Scaboo; USDA/ARS: Patrick Elia; SARI: Nicholas Denwar, Francisca Addae-Frimpongmaa, Jalilatu Ayuba, Zackaria W. Osman, Duut Martey, Saaka Buah, James M. Kombiok, R.A.L Kanton; SFSA: Dominik Klauser, Ian Barker, Clive Barker; JARC: Abush Tesfaye; IITA: Godfree Chigeza

iii) **Achievements:**

- Significantly expanded the pace, output and efficiency of the leading breeding hubs in West, East and Southern Africa through mentorship, training, infusion of diverse genetic material and introduction of planting and harvesting mechanization. Breeding programs are set to introduce new, high-yielding and locally-adapted varieties to smallholder farmers in project time frame.
- Successfully partnered to introduce seed lab & irrigation infrastructure to SARI, critical for seed quality assurance and program output as irrigation allows multiple seasons of testing in a year
- Implemented the region’s leading Master’s Degree in Plant Breeding & Genetics degree program to fill the void of quality-trained individuals to manage African soybean research programs
- Developed the first low-processing and low-phosphorous soybean varieties and began the first research to understand how the genetic components of the long juvenile trait, maturity (E genes), and stem architecture play a role in adapting temperate soybean to tropical climates and how this can be applied to increasing smallholder farmer yields

iv) **Capacity Building:** At the individual level through direct mentorship of soybean breeding leads and the WACCI student cohorts and at the institutional level through infrastructure and process improvements for mechanization, irrigation, seed lab development and IT connectivity.

v) **Lessons Learned:** SIL learned the importance of focused, constant, targeted and direct mentorship of, and investment in, the leading soybean breeders to ensure fundamental transformations

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§ These should be one page per project, limited to summaries of project objectives, key activities, highlights and process toward outcomes (not scientific reports or long detailed research papers).
upstream in the seed development system that transform the output and pace of programs rather scattered superficial investments to non-critical nodes in Africa’s seed system.

vi) Presentations and Publications – link 1; link 2; link 3; link 4
b) Objective 2: Crop Productivity and Quality

iii) Description: Integrated with the genetic improvement program, SIL is conducting complementary soybean agronomic research using the novel concept of a SMART Farm that implements a rigorous applied research trial program. The SMART farm production research center was designed to be replicable for the missions, depending on their goals and objectives. The first of these SMART Farms was developed at SARI in northern Ghana. Three years of agronomic research data have been produced by the SIL SMART Farm in the Northern, Upper East, and Upper West regions of Ghana including recommendations for smallholder farmers on soil correction; seed germination; nutrient amendments; variety yields; planting date; and plant population. The SMART Farm also serves as a hub for conducting pesticide use training for practitioner groups.

The Crop Productivity and Quality component of the SIL program also focuses on transitioning not only research stations, but smallholder farmers to mechanization such as planters and threshers. At the research level this enables evaluation of a greater number of varieties, utilization of larger test plots to evaluate varieties/planting dates/plant populations etc. and uniform planting depths and timely planting dates. At the smallholder farmer level this reduces drudgery due to hand threshing, saves labor and improves seed quality dramatically. To this end SIL designed a low-cost, locally-produced crop thresher to respond to the need for appropriate-scale harvest technologies.

iv) Collaborators: MSU: Dan Reynolds, George Awuni; MU: Kerry Clark; SARI: Gabriel Abdulai; CRS: Mawuli Asigbee, Philip Atiim; MEDA: Catherine Sobrevega

v) Achievements:

- Guidance from the three years of evidence-based data generated at the SIL SMART Farm shows that when combining appropriate agronomic practices, soybean yields using locally available varieties can be increased over 2.5 times average farmer yields in Northern Ghana. These agronomic practices include planting date, row spacing, seed spacing, and seed population with appropriate inputs, like phosphorus and inoculum. The SIL SMART Farm model provides 1) consistent, reliable and scientific agronomic recommendations for smallholder farmers; 2) equips contractors, extensionists, agronomists and the government with the technical guidance needed to make their farmer groups successful soybean producers; and 3) reflects the criticality of rigorous controls, replication and extension partnerships to assure practitioners and farmers have access to high quality and reliable agronomic and production guidance and recognizes the local nature of soybean with multiple on-station and matched on-farm trial sites.

- SIL recognized that low cost, small scale, locally produced threshers could provide a solution to harvest crops like soybean. In 2016, SIL held an 8-day training to teach 12 local blacksmiths and workers at the TIF how to fabricate small-scale crop threshers for use in Northern Ghana. The blacksmiths learned not only how to fabricate the threshers, but received business training, and constructed three threshers which will be distributed to three villages in Northern Ghana. SIL is developing design books and a training module for organizations interested in creating similar workshops and has created an international thresher design network.

iv) Capacity Building: At the individual level by equipping 12 blacksmiths in northern Ghana with the technical knowledge to fabricate, maintain, repair and sell low-cost, locally-produced soybean threshers and at the institutional level equipped the TIF, a local Ghanaian organization specializing in equipment manufacturing, and CRS on how to run a mechanization training activity.

v) Lessons Learned: The need for appropriate-scale, low-cost and locally-produced crop harvesting technologies, as well as reliable, local and data-driven agronomic guidance is a critical need throughout Africa with all practitioner groups seeking to produce soybean. SIL is developing agronomic and equipment networks throughout Africa to respond to this need.

vi) Presentations and Publications: Link 1; Link 2; Link 3; Link 4
c) Objective 3: Nutrition  
i) Description: As soybean is a non-native food stuff, SIL research focuses on how training in the proper handling, processing, and utilization of soybean within local recipes in the household affect the sustainability of human soybean utilization. Utilizing soybean at the household level requires basic knowledge of at-home soy processing techniques and methods for incorporating soy ingredients like soy milk, tofu, and soy flour into local foods to ensure acceptability and sustained use. To increase knowledge on the nutritional benefits and methods of processing soy, SIL provides intensive village level trainings and interactive and hands-on workshops focused on soy processing, soy nutrition and soy integration into local cooking applications. SIL is also conducting a study assessing the feasibility and acceptability of a soy-fortified complementary food product among mother-infant groups in northern Ghana. If deemed acceptable, this soy-based complementary food would play an important role in SIL’s broader mission of introducing more high-quality protein to regions vulnerable to malnutrition.

SIL began the Soy Dairy Entrepreneur Network, the first of its kind, which paves the way to build sustainable enterprises by connecting soy food operations throughout Africa to share their gathered experience, business practices, training, and technological knowledge. SIL trains the network on packaging solutions, product development, business planning, marketing, branding, and more. Establishing a sound foundation for soy dairy entrepreneurs will, SIL hopes, spur more successful businesses, and in turn stimulate economic development, youth employment, improve nutrition, and reduce poverty. Finally, converting raw soybean into a readily consumable product is a complex process that limits widespread consumption in many developing countries. One of the challenges associated with increasing soy consumption is that soybean requires significant heating and processing to remove or neutralize anti-nutritional parts of the plant, such as trypsin inhibitors. The time and infrastructure needed to support soy processing is costly, so SIL developed a low-processing, African-adapted soybean variety to address this challenge.

ii) Collaborators: UIUC: Juan Andrade, Margaret Cornelius, Marilyn Nash; SARI: Flora Amagloh; UDS: Francis Amalgoh; MU: Kristin Bilyeu; CSIR-FRI: Mary Glover, Frank Peget; AA Pure Soy Milk Factory: Joseph Osei, Winnua Ltd.: Asa Maria Tham; CRS: Mawuli Asigbee

iii) Achievements:
- SIL conducted soy processing, utilization and nutrition intensive training to three villages in North and Central Mozambique in 2016
- SIL began the framework for its soy-based complementary food study taking place in four villages in Northern Ghana with 170 mother-infant pairs who will taste test the complementary food and test the feasibility by preparing the food at home for two weeks.
- SIL engaged 20 soy dairy enterprises in 6 countries in its Soy Dairy Entrepreneur Network, providing training and guidance to business to ensure sustainable soy food enterprises.
- SIL developed a new, low-processing soybean line that meets household and industry demands for a high-quality, affordable protein resource with minimal effort in terms of processing. The low-processing lines reduce the processing burden on farmers and processors, enabling African soybeans to be more readily utilized for growing human and livestock nutrition demands.

vii) Capacity Building: SIL provides entrepreneurs within its Soy Dairy Entrepreneur Network technical training, guidance and benchmarking to ensure the success & sustainability of their businesses. SIL collaborates with SARI & UDS on a soy-based complementary food feasibility & acceptability study.

viii) Lessons Learned: Soy dairy and soy food enterprises throughout Africa struggle to build sustainable businesses. SIL has learned the criticality of complementing management training and tools with the imported dairy processing equipment to form real businesses.

ix) Presentations and Publications: Link 1; Link 2; Link 3; Link 4; Link 5
d) **Objective 4: Value Chains & Socio-Economic Research**

i) **Description:** SIL established the first controlled research study involving soybean introduction among smallholder farmers using two gender and socio-economic focused surveys: the WEAI+ and the SUNS. The overarching research questions under study are the appropriateness of soybean as a technology for development, and the associated implications for smallholder farmers in general and women in particular. These surveys cover the soybean value chain from input markets through to grain sale and local utilization and address within sustainable soybean systems issues of technology adoption and drivers for adoption, value chains and the role of credit and savings, crop and utilization budgets, and gender equity and the role of women. Both surveys are being implemented in Mozambique and Ghana and are utilizing the SIL-designed “Soybean Success Kits” as the treatment instrument to assess differences in households that received the treatment vs. those who did not. The “Soybean Success Kits” provide all the necessary inputs for successful smallholder soybean production (seed, fertilizer, inoculum and pictorial extension information). Recipients also received soybean agronomic training. Kits were first distributed in 2015 with subsequent distribution in 2016 utilizing a design that allows SIL researchers to assess the role of network connectedness and SIL-implemented nutrition and soy processing trainings on soybean uptake.

The baseline WEAI+ survey was implemented in Ghana and Mozambique prior to the kit distribution to understand baseline characteristics of soybean smallholder farmers. SIL used survey responses to construct a composite measure of empowerment for each person across 5 domains of empowerment and using 10 indicators. SIL trained in-country partner organizations and enumerators on the survey administration. The WEAI+ will be repeated in Year 5 of the SIL program with the same respondents to understand changes in gender empowerment across these scales.

An additional SIL-designed survey, the SUNS, is being implemented in Ghana and Mozambique to understand and characterize the bottlenecks that may limit smallholder soybean adoption. These fundamental questions have yet to be analyzed in the development context. The SUNS particularly looks at the economic impact of soybean introduction at the smallholder level by understanding purchase and utilization of inputs, labor allocation, gender biases, ICT importance, the minimum efficient scale, market failures, and spatial constraints. The SUNS enables the study of more applied questions including alternative models of bundling seed, inputs, training to optimize adoption and sustained production, differing approaches to ICT extension and new models promoting greater financial liquidity. SIL research is also the first to explore the substitution phenomenon as soybean production may result in the potential diversion of land from other crop/livestock uses to soybean.

ii) **Collaborators:** MU: Jill Findeis, Nina Furstenau, Fridah Mubichi; MSU: Kathleen Ragsdale, Mary Read-Wahidi, Audrey Reid; CRS: Mawuli Asigbee, Ewurabena Yanyi-Akofur, Emmanuel Osei-Mensah; IIAM: Maria da Luz Quinhentos, Magalhaes Miguel

iii) **Achievements:**
- 4,800 kits distributed to smallholder farmers; soybean agronomy training for 8,000 people
- 884 WEAI+ respondents were surveyed in Mozambique and 675 in Ghana
- 834 participants in 4 districts in Ghana’s Northern Region participated in the SUNS study

iv) **Capacity Building:** SIL worked with in-country partners CRS and IIAM to train enumerator teams on implementation of the WEAI+ and SUNS and utilizing tablets to survey respondents electronically.

v) **Lessons Learned:** Results from the WEAI+ show large regional differences in soybean uptake by both men and women, input utilization among smallholders is very low, with few farmers reporting the use of inoculum, fertilizers or pesticides. Findings also show women are more likely than men to receive seed from relatives in their village, express a willingness to try soy as an enterprise, but are less likely to speak up in public than men, a challenge that reduces their empowerment.

vi) **Presentations and Publications:** [Link 1]; [Link 2]; [Link 3]; [Link 4]
**VI) Human and Institutional Capacity Development**

a) Short-term training

<table>
<thead>
<tr>
<th>Country of Training</th>
<th>Brief Purpose of Training</th>
<th>Who was Trained††</th>
<th>Number Trained‡‡</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cote d’Ivoire</td>
<td>SIL PI training on implementation of SMART Farm concept and low-cost locally-produced thresher design contest</td>
<td>CDI</td>
<td>1 M 1 F 1 Total</td>
</tr>
<tr>
<td>Ethiopia</td>
<td>SIL PI training on breeding program management; data collection; equipment utilization; breeding techniques and training on the Breeding Management System/Integrated Breeding Platform</td>
<td>JARC</td>
<td>5 M 0 F 5 Total</td>
</tr>
<tr>
<td>Ethiopia</td>
<td>African Plant Breeding Academy Class II</td>
<td>JARC</td>
<td>1 M 0 F 1 Total</td>
</tr>
<tr>
<td>Ghana (Northern Region)</td>
<td>African Plant Breeding Academy Class II</td>
<td>SARI</td>
<td>1 M 0 F 1 Total</td>
</tr>
<tr>
<td>Ghana (Upper West Region)</td>
<td>SIL PI training on SUNS enumeration</td>
<td>CRS enumerator team</td>
<td>16 M 4 F 20 Total</td>
</tr>
<tr>
<td>Ghana (Upper West, Upper East and Northern Regions)</td>
<td>SIL PI training on thresher fabrication, business and marketing training</td>
<td>Local Blacksmith Community; Tamale Implement Factory; SARI</td>
<td>16 M 0 F 16 Total</td>
</tr>
<tr>
<td>Ghana (Northern Region)</td>
<td>SARI field demonstrations showcasing varieties at planting and maturity stages</td>
<td>Smallholder farmers</td>
<td>217 M 488 F 705 Total</td>
</tr>
<tr>
<td>Ghana (Northern Region)</td>
<td>SARI sensitization of staff and students on health and nutrition benefits of soybean; Distribution of soymilk to staff and students; sensory evaluation of soymilk</td>
<td>Students and staff from JHS 2 and JHS 3</td>
<td>Not available M Not available F 110 Total</td>
</tr>
<tr>
<td>Ghana (Northern Region)</td>
<td>SARI sensitization, training and participatory demonstrations on producing local dishes with soybean; video show and practical demonstrations of soymilk and tofu production; focus groups on lessons learned; and soybean nutritional and health benefits</td>
<td>Smallholder farmers</td>
<td>12 M 374 F 386 Total</td>
</tr>
<tr>
<td>Ghana (Northern Region)</td>
<td>SARI sensitization on the importance of including soybean in the diet; sensory</td>
<td>Students and staff from St. Monica’s School</td>
<td>Not available M Not available F 1,096 Total</td>
</tr>
</tbody>
</table>

**††** Such as farmers, government officials, women entrepreneurs

**‡‡** Disaggregate by sex if known

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**This section is to serve as a compilation of all program training activities for the 12-month reporting period and not meant to duplicate the Capacity Building section under individual Research Project Reports.**
<table>
<thead>
<tr>
<th>Region)</th>
<th>Evaluation of soymilk; discussion of integrating soymilk into school feeding program</th>
<th>able</th>
<th>able</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ghana (Northern Region)</td>
<td>SIL PI training on breeding program management; data collection; equipment utilization; breeding techniques and training on the Breeding Management System/Integrated Breeding Platform</td>
<td>SARI Soybean Breeding Staff</td>
<td>8</td>
</tr>
<tr>
<td>Ghana (Northern Region)</td>
<td>SIL PI training on soybean value chain development (in line with needs expressed by partner organizations needs and guidance from SIL program)</td>
<td>SIL Partner Organizations</td>
<td>18</td>
</tr>
<tr>
<td>Ghana (Upper West and Northern Regions)</td>
<td>SIL PI training and introduction on SMART Farm model of soybean agronomic research and extension to develop this model in Nigeria and Liberia</td>
<td>SIL &amp; Church of the Brethren</td>
<td>8</td>
</tr>
<tr>
<td>Ghana (Northern Region)</td>
<td>1st annual Soybean Success Kit event showcasing SIL plant breeding, agronomic and nutrition efforts</td>
<td>Smallholder farmers; input dealers; NGOs; MOFA; SARI; SIL; Practitioner Groups</td>
<td>125</td>
</tr>
<tr>
<td>Ghana Northern Region</td>
<td>SIL Exhibition Booth focused on SIL SMART Farm model of soybean agronomic research and extension and SIL soybean breeding activities for farmers and practitioner groups in northern Ghana</td>
<td>Attendees to annual Pre-Harvest Event</td>
<td>N/A</td>
</tr>
<tr>
<td>Ghana Northern Region</td>
<td>SIL PI presentation on the “Effects of phosphorus fertilizer on soybean”</td>
<td>N2Africa Stakeholder Workshop on Sustainable Supply of Legume Inputs in Northern Ghana</td>
<td>N/A</td>
</tr>
<tr>
<td>Ghana (Northern, Greater Accra and Ashanti Regions)</td>
<td>SIL PI guidance on establishing a successful soy diary system including benchmarking performance; business plan and marketing plan development; packaging options and sales generation</td>
<td>CSIR-FRI; AA Pure Soy Milk Factory; CSIR-SARI</td>
<td>1</td>
</tr>
<tr>
<td>Ghana (Greater Accra Region)</td>
<td>African Plant Breeding Academy Class II</td>
<td>WACCI</td>
<td>1</td>
</tr>
<tr>
<td>Ghana (Greater Accra Region)</td>
<td>SIL/WACCI-delivered Statistics I Training Course</td>
<td>WACCI</td>
<td>N/A</td>
</tr>
<tr>
<td>Ghana (Greater Accra Region)</td>
<td>SIL/WACCI-delivered Molecular Marker Analysis Training Course</td>
<td>WACCI</td>
<td>N/A</td>
</tr>
<tr>
<td>Ghana (Greater Accra Region)</td>
<td>SIL/WACCI-delivered Plant Breeding Module Training Course</td>
<td>WACCI</td>
<td>N/A</td>
</tr>
<tr>
<td>Ghana (Greater Accra Region)</td>
<td>SIL PI training on successful event management; survey implementation; project planning</td>
<td>CRS</td>
<td>1</td>
</tr>
<tr>
<td>Kenya</td>
<td>SIL PI guidance and training on soybean association development; soybean</td>
<td>Soyake Association</td>
<td>4</td>
</tr>
<tr>
<td>Country/Region</td>
<td>Description</td>
<td>Partner</td>
<td>U.S.</td>
</tr>
<tr>
<td>---------------</td>
<td>-------------</td>
<td>---------</td>
<td>------</td>
</tr>
<tr>
<td>Kenya</td>
<td>SIL PI training on Pan-African varietal trial program management; data collection process; and varieties and metrics to evaluate</td>
<td>SFSA</td>
<td>4</td>
</tr>
<tr>
<td>Malawi</td>
<td>SIL PI training on breeding program management; data collection; equipment utilization; breeding techniques</td>
<td>IITA Assistant Soybean Breeders</td>
<td>1</td>
</tr>
<tr>
<td>Mozambique (Northern and Central Regions)</td>
<td>SIL PI training on soy processing for soymilk, tofu and soy flour; utilization in the Mozambican diet and nutrition education</td>
<td>Smallholder farmers</td>
<td>42</td>
</tr>
<tr>
<td>Mozambique (Northern Region)</td>
<td>SIL PI training on seed contamination in increase and research plots</td>
<td>IITA Soybean Agronomic Team</td>
<td>2</td>
</tr>
<tr>
<td>Mozambique (Central Region)</td>
<td>SIL PI training on SUNS implementation</td>
<td>IIAM Soybean Team</td>
<td>3</td>
</tr>
<tr>
<td>Ghana (Central and Southern Regions)</td>
<td>SIL PI guidance on establishing a successful soy dairy system including benchmarking performance; business plan and marketing plan development; packaging options and sales generation</td>
<td>Winnua Ltd., Association Pala Wassokoti</td>
<td>1</td>
</tr>
<tr>
<td>U.S.</td>
<td>SIL Webinar “Building the Network of Soy Dairy Processing Enterprises” focused on the Soy Dairy Entrepreneur Network including the services SIL provides in terms of soy packaging, business, marketing and investment plans and other technical guidance</td>
<td>Soy Dairy Enterprise Network Affiliates</td>
<td>43</td>
</tr>
<tr>
<td>U.S.</td>
<td>SIL Webinar “Packaging Techniques to Improve Soy Food Shelf Life” focused on different packaging techniques and processes for soy dairy and soy food products in various environments throughout Africa</td>
<td>Soy Dairy Enterprise Network Affiliates</td>
<td>37</td>
</tr>
<tr>
<td>U.S.</td>
<td>SIL In-Person and Live Streamed Event “Crop Intensification in the Tropics” looking at the particular case of soybean in the tropics</td>
<td>Agricultural &amp; Applied Economics Association Annual Meeting attendees</td>
<td>61</td>
</tr>
<tr>
<td>U.S.</td>
<td>SIL Webinar “Meet the Next Generation of Plant Breeders” looking at the role of high-quality graduate education in soybean breeding in Africa</td>
<td>USAID/Ghana &amp; SIL partners</td>
<td>13</td>
</tr>
<tr>
<td>U.S.</td>
<td>SIL training on the role of soy in early child nutrition, the Soy Dairy Entrepreneur Network and soy</td>
<td>New SIL Human Nutrition PI</td>
<td>0</td>
</tr>
</tbody>
</table>
processing, utilization and nutrition education trainings to enhance the sustainability of soy production

<table>
<thead>
<tr>
<th>Country</th>
<th>Description</th>
<th>Instructor(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zambia</td>
<td>SIL PI training on breeding program management; data collection; equipment utilization; breeding techniques and training on the Breeding Management System/Integrated Breeding Platform</td>
<td>IITA Head Soybean Breeder</td>
</tr>
<tr>
<td>Zambia</td>
<td>SIL PI training at round table meeting on objectives and progress of the IITA breeding program; discussion of needs of the private sector; and opportunities for collaboration on soybean agronomic research</td>
<td>IITA &amp; Private Sector Soybean Seed Companies</td>
</tr>
</tbody>
</table>

b) Long-term training

<table>
<thead>
<tr>
<th>Name (first, last)</th>
<th>Sex</th>
<th>University</th>
<th>Degree</th>
<th>Major</th>
<th>Program End Date§§ (month/year)</th>
<th>Degree Granted***</th>
<th>Home Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frederick Justice Awuku</td>
<td>M</td>
<td>WACCI</td>
<td>M.S.</td>
<td>Plant Breeding &amp; Genetics</td>
<td>May 2017</td>
<td>TBD</td>
<td>Ghana</td>
</tr>
<tr>
<td>George Awuni</td>
<td>M</td>
<td>Mississippi State University</td>
<td>Post-Doc</td>
<td>Entomology &amp; Plant Pathology</td>
<td>N/A</td>
<td>N/A</td>
<td>Ghana</td>
</tr>
<tr>
<td>Kassaye Hussen Belay</td>
<td>M</td>
<td>WACCI</td>
<td>M.S.</td>
<td>Plant Breeding &amp; Genetics</td>
<td>May 2017</td>
<td>TBD</td>
<td>Ethiopia</td>
</tr>
<tr>
<td>Gameli Collins Gborvi</td>
<td>M</td>
<td>WACCI</td>
<td>M.S.</td>
<td>Plant Breeding &amp; Genetics</td>
<td>May 2017</td>
<td>TBD</td>
<td>Ghana</td>
</tr>
<tr>
<td>Prince Buertey Kpentey</td>
<td>M</td>
<td>WACCI</td>
<td>M.S.</td>
<td>Plant Breeding &amp; Genetics</td>
<td>May 2017</td>
<td>TBD</td>
<td>Ghana</td>
</tr>
<tr>
<td>Heather Guetterman</td>
<td>F</td>
<td>University of Illinois</td>
<td>B.S.</td>
<td>Food Science</td>
<td>May 2016</td>
<td>Y</td>
<td>USA</td>
</tr>
<tr>
<td>Carrie Miranda</td>
<td>F</td>
<td>University of Missouri</td>
<td>PhD</td>
<td>Plant Breeding</td>
<td>May 2017</td>
<td>TBD</td>
<td>USA</td>
</tr>
<tr>
<td>Edward Martey</td>
<td>M</td>
<td>University of Illinois</td>
<td>PhD</td>
<td>Agricultural Economics</td>
<td>May 2020</td>
<td>TBD</td>
<td>Ghana</td>
</tr>
<tr>
<td>Michael Maw</td>
<td>M</td>
<td>University of Missouri</td>
<td>M.S.</td>
<td>Crop Physiology</td>
<td>May 2017</td>
<td>TBD</td>
<td>USA</td>
</tr>
<tr>
<td>Molly Messner</td>
<td>F</td>
<td>University of Illinois</td>
<td>B.S.</td>
<td>Agricultural Economics</td>
<td>May 2016</td>
<td>Y</td>
<td>USA</td>
</tr>
<tr>
<td>Fridah Mubichi</td>
<td>F</td>
<td>University of Missouri</td>
<td>Post-Doc</td>
<td>Rural Sociology</td>
<td>N/A</td>
<td>N/A</td>
<td>Kenya</td>
</tr>
<tr>
<td>Godson Nyawudzo</td>
<td>M</td>
<td>WACCI</td>
<td>M.S.</td>
<td>Plant Breeding &amp; Genetics</td>
<td>May 2017</td>
<td>TBD</td>
<td>Ghana</td>
</tr>
</tbody>
</table>

§§ Anticipated graduation date or end of program support
*** Indicate if program support resulted in a degree
Feed the Future Innovation Lab for Soybean Value Chain Research  

<table>
<thead>
<tr>
<th>Name</th>
<th>Gender</th>
<th>Institution</th>
<th>Degree</th>
<th>Year</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mary Rebecca Read-Wahidi</td>
<td>F</td>
<td>Mississippi State University</td>
<td>Post-Doc</td>
<td>Medical Anthropology</td>
<td>N/A</td>
</tr>
<tr>
<td>Xiaoge Tang</td>
<td>F</td>
<td>University of Illinois</td>
<td>M.S.</td>
<td>Civil Engineering</td>
<td>May 2016</td>
</tr>
<tr>
<td>Armand Tossou</td>
<td>M</td>
<td>University of Illinois</td>
<td>PhD</td>
<td>Agricultural Economics</td>
<td>May 2020</td>
</tr>
<tr>
<td>(Forthcoming)</td>
<td>F</td>
<td>Kwame Nkrumah University of Science and Technology</td>
<td>M.S.</td>
<td>(Forthcoming)</td>
<td>(Forthcoming)</td>
</tr>
</tbody>
</table>

**Institutional Development**

i) **Description:** SIL directly engages at the human and institutional level in capacity building to successfully implement its programs and ensure partner practitioner groups are successful when the SIL program concludes. This involves direct mentorship of research leads and technical guidance to institutions on research infrastructure investments, process improvements, financial management, project reporting, communications and IT infrastructure support and event management. Capacity building and institutional development also involve providing the technical guidance and innovation to enable practitioner partner groups to be successful in providing future training and guidance to their farmer groups and other beneficiaries.

ii) **Partners:**
1. AA Pure Soy Milk Factory
2. CRS
3. CSIR-FRI
4. CSIR-SARI
5. IITA
6. MEDA
7. MOFA/Ghana
8. RING
9. SFSA
10. UDS
11. WACCI
12. CDI
13. JARC
14. EIAR
15. EthioChicken
16. TechnoServe
17. Greenspec Ltd.
18. LUANAR
19. Association Pala Wassokoti
20. IIAM
21. Winnua Ltd.
VII) Technology Transfer and Scaling Partnerships (if applicable to your Lab)

While this is not a requirement of the SIL program, the research team is committed to developing scalable technologies and innovations useful for the practitioner community seeking to develop soybean in the tropics.

a) Plan of Action

i) Steps taken

SIL directly engages with practitioner groups (researchers, the private sector, firms, non-governmental organizations, extensionists, agronomists, technicians, farmer associations, government agencies) as well as with in-country USAID-mission funded programs, the private sector and with programs funded by other governments, foundations and institutions to provide them with data-driven, evidence-based technical knowledge and innovation to help them achieve success in their soybean development efforts. SIL engages in partnerships, trainings, event development, resource sharing, field visits and meetings to provide technical guidance and direction to these practitioner groups.

ii) Partnerships made

To date, SIL has engaged in technical guidance partnerships with the following practitioner groups:

1. U.S.: COB; MU; MSU; UMES; UGA; USDA/ARS; WFP
2. Ghana: AA Pure Soy Milk Factory; ACDI/VOCA; CRS; CSIR-FRI; CSIR-SARI; Green-Ef Eco Business Village; IFDC; IITA; Jaksally; MEDA; MOFA/Ghana; Omya International; RING; SADA; SFSA; SPRING; UDS; USAID/Ghana; WACCI
3. Cote d’Ivoire: CDI
4. Ethiopia: JARC; EIAR; EthioChicken; Hilna Enriched Foods; SFSA; TechnoServe; USDA/FAS
5. Indonesia: SFSA
6. Kenya: Greenspec Ltd.; SFSA
7. Malawi: IITA; LUANAR
8. Mali: SFSA
9. Mozambique: Association Pala Wassokoti; GAIN; IIAM; IITA; USAID/Mozambique; Winnua Ltd.
10. Nigeria: COB; IITA
11. Rwanda: CDI; SFSA
12. Switzerland: SFSA
13. Zambia: IITA; Syngenta; SFSA; ZamSeed
14. Zimbabwe: Seed Co Ltd.; SFSA; USAID/Zimbabwe

iii) Technologies transferred

1. Diverse germplasm from USDA Soybean Germplasm Collection
2. Plant breeding equipment including planters and threshers
3. Low-cost, locally-produced crop threshers
4. Soybean Success Kits (improved seed, fertilizer, inoculum, pictorial extension)
5. A Statistics for Plant Breeders course
6. An Introduction to Plant Breeding course
7. A SMART Approach to Soybean Production
8. A Pesticide Safety for Farm Workers, a training course
9. Soy Dairy Entrepreneur Network Technical Training Program
10. Soy Processing, Utilization & Nutrition Education Village-Level Training Program
11. Pan-African Soybean Varietal Trial Program

iv) Technologies scaled
1. Diverse germplasm from USDA Soybean Germplasm Collection
2. Low-cost, locally-produced crop threshers
3. Soybean Success Kits (improved seed, fertilizer, inoculum, pictorial extension)
4. A SMART Approach to Soybean Production, an extension program
5. Soy Dairy Entrepreneur Network Technical Training Program
6. Pan-African Soybean Varietal Trial Program

v) Technologies ready to scale
1. Plant breeding equipment including planters and threshers
2. A Statistics for Plant Breeders course
3. An Introduction to Plant Breeding course
4. A Pesticide Safety for Farm Workers, a training course
5. Pan-African Soybean Varietal Trial Program

VIII) Environmental Management and Mitigation Plan (EMMP)
SIL is a leader in implementing, tracking and monitoring a robust EMMP for its project. SIL tracks all of its output and progress towards its EMMP through a shared online resource available to all SIL researchers. This shared resource contains receipts of purchase of inoculum and fertilizer at all research sites; maps and coordinates of research sites to ensure appropriate distance from water sources and other protected and/or sensitive areas; receipts of purchase and shipment of Personal Protective Equipment (PPE) for all research sites to ensure proper pesticide use and storage; photos of pesticide and chemical storage facilities; copies of commercial applicator certifications for research station managers; EPA registrations for all pesticide and chemicals used at research sites; presentations related to EMMP monitoring and implementation and other educational materials related to appropriate pesticide use and environmental stewardship and management. The SIL team also discusses progress towards its EMMP at its annual researcher retreat meeting held every December and also briefs the USAID AOR on progress.

IX) Open Data Management Plan
The SIL Data Management Plan (DMP) was submitted to USAID/BFS/D.C. on October 22, 2015. No changes to the existing DMP to report on this year

X) Governance and Management Entity Activity
The SIL team is managed by the Principal Investigator, the Program Manager and the Communications Director. The duties of the administrative team are to:
- Provide logistical support, promote collaboration, and coordinate project planning and implementation
  - Provide logistical support for project activities and ensure efficient project management
    - Oversee financial management and collect monthly invoices from subawardees
    - Provide financial reporting to USAID
    - Determine upcoming travel plans of team members and report to USAID
- Promote collaboration and coordination among team members and collaborators
  - Convene monthly conference calls for team members
  - Continue utilization of project management software
  - Convene annual SIL researcher meeting
- Coordinate project planning and implementation
Feed the Future Innovation Lab for Soybean Value Chain Research

- Travel to SIL core/focus countries in Africa to monitor research progress
- Monitor and evaluate project progress and ensure alignment with critical needs
  - Submit fourth and fifth semi-annual reports
  - Submit SIL annual work and travel plans
  - Submit Feed the Future Indicators through FTFMS
- Provide communication on SIL activities & research
  - Convene bi-annual meetings of the SIL Advisory Board
  - Give seminars and publish project results
  - Meet with USAID Missions and other stakeholders
  - Implement annual Soybean Kickoff and Soy Food Bazaar events
- Continue providing input for Feed the Future newsletters, publications and events
  - Continue responding to USAID Request for Proposals
- Manage SIL Website, Tropical Soybean Information Portal & Newsletter
  - Utilize Twitter and other social media platforms to communicate SIL activities and objectives
- Provide support for organizations interested in utilizing soybean in development
  - Respond to soybean in development inquiries
- Provide strategic and mentoring support to SIL researchers and partners to maximize the productivity and effectiveness of development investments
- Expand SIL efforts
  - Continue discussions with USAID missions through submission of concept notes, 2-page overview documents, white papers, conference calls, etc. to determine ways in which SIL can strengthen and provide research background/support for mission efforts
  - Continue submitting proposals to private foundations, Feed the Future Innovation Labs, federal government agencies (USDA, etc.), U.S. universities, and other funding sources to expand the ability of SIL to respond to research needs from the soybean development and practitioner communities

XI) Other Topics†††
- The World Bank recently awarded a four-year grant to the Lilongwe University of Agriculture and Natural Resources (LUANAR), in Lilongwe, Malawi to establish an African Center of Excellence (ACE) in Aquaculture and Fisheries (the “AquaFish Centre”). The Soybean Innovation Lab (SIL) will serve as the lead international research partner for the AquaFish Centre. LUANAR will collaborate with SIL and its partners at the University of Illinois and Mississippi State University on soybean meal processing, feed manufacturing, warm water aquaculture nutrition, and warm water aquaculture production. The Soybean Innovation Lab and its partners will work to make the LUANAR AquaFish Centre not just a center of academic excellence, but also an economic engine supporting the growth of the aquaculture industry in Southern and Eastern Africa. SIL will collaborate with LUANAR on critical infrastructure and equipment upgrades, on-site technical training, and industry support services. SIL will support LUANAR as it creates a high quality masters and doctoral program in aquaculture. SIL and the AquaFish Centre will also work together to implement a seed grant program. The small research grant program will bring U.S. and Malawian researchers together with the intent to build an applied research program that will sustain the graduate program after the initial World Bank support concludes. The AquaFish Centre will be established as an industry service center capable of supporting the growing aquaculture industry in the region. The Centre will develop a sustainable stream of industry partnerships and research contracts. These public/private partnerships will provide the

††† Such as Regional Centers of Excellence, impact assessment, gender initiatives
AquaFish Centre with a key revenue source critical to ensuring the longevity and sustainability of the program. The grant and collaboration is scheduled to begin later in 2016.

- We are the first Innovation Lab, we are aware of, to implement a SIL Gender Responsive Agricultural Development Assessment–Wave I (SIL GRADA-I), an online survey (via Qualtrics) for persons in organizations affiliated with the Soybean Innovation Lab in the US and abroad (e.g., our project researchers and implementing partners). The capacity of the USAID Feed the Future (FTF) Soybean Innovation Lab (SIL) to effectively implement gender responsive agricultural development can greatly impact SIL’s ability to accomplish our mission to improve soybean sustainability and food security in our FTF Zones of Influence in sub-Saharan Africa. Therefore, we are requesting 1) senior researchers, senior management (e.g. PI, Co-PI, CEO, Chief of Party, Director, Deputy Director that are involved with SIL activities); 2) research scientists, postdoctoral fellows, research assistants, program staff; 3) administrative or technical staff; 4) graduate students; 5) undergraduate students; 6) consultants; and 7) SIL advisory board members to participate in the survey. The purpose of this survey is to assess perspectives on gender integration into SIL activities among SIL researchers and implementing partners. The findings of this research will be used to help ensure SIL practices promote gender responsive agricultural development in our FTF Zones of Influence in sub-Saharan Africa. Results of the survey will help us understand needs for better communication, training, tools, and resources.

- SIL researcher Dr. Kathleen Ragsdale was selected to attend a 5-day Technical and Operational Performance Support (TOPS) Program workshop in Washington, D.C. in August 2016. TOPS is the USAID/Food for Peace-funded learning mechanism that generates, captures, disseminates, and applies the highest quality information, knowledge, and promising practices in development food assistance programming to ensure that more communities and households benefit from the U.S. Government’s investment in fighting global hunger. Through technical capacity building; a small grants program to fund research, documentation, and innovation; and an in-person and online community of practice, the Food Security and Nutrition (FSN) Network, TOPS empowers food security implementers and the donor community to foster lasting impact for millions of the world’s most vulnerable people.

- SIL Principal Investigator Dr. Peter Goldsmith was selected to participate in the Bureau for Food Security of USAID and the Michigan State University/IFPRI/University of Pretoria Food Security Policy Innovation Lab-sponsored roundtable "Cities and the Future of Agriculture and Food Security: A Programmatic and Policy Roundtable” in March 2016. The panelists and participants represented various policy institutes and the US Government. The goal of the roundtable was to help inform USAID food security programming and serve as a point of reference for the Agency. The event was also used to craft a series of high-impact, agenda-setting articles focused at a broader audience of policymakers and academics. The roundtable comprised four, two-hour discussion sessions, each focused on a particular theme. The four themes included 1) Urbanization: the extent and pace of urbanization; the implications of urbanization for urban poverty, food security, and long term economic growth; and the extent to which USAID food security programs should engage in urban areas; 2) Urbanization and food demand; consumer needs and opportunities for value chain growth: the implications of urbanization patterns for food demand, and the challenges and opportunities associated with nutrition, dietary diversity, and overconsumption; 3) Urbanization and the role of secondary cities for agro-industries, services, and factor provisioning: the role of secondary cities in spurring local agricultural growth and greater interchange – of outputs, services, and factors including labor - between rural- and urban areas; 4) Urbanization and agricultural production: the implications of urbanization for
farmers, and for rural wage labor. Specifically, this theme will examine how farming is likely to be reshaped by changing urban demand.

- SIL researchers Dr. Kerry Clark and Dr. Dennis Thompson created a new American Society of Agronomy (ASA) community focused on “Tropical Legumes”. In 2016 Dr. Clark chaired the community and Dr. Thompson served as the vice chair. At the upcoming ASA annual meeting in Phoenix, Arizona in November 2016 the SIL-developed Tropical Legumes community will host a Symposium on Transforming Smallholder Agronomy in Africa which will address the achievement of higher rate of adoption of good agronomic practices by African smallholder farmers. The 2-hr symposium will consist of 10 5-min presentations of key lessons learned plus one hour of discussion of the lessons presented as well as to address future activities of Agronomy in Africa, a new ASA community. The symposium will bring together members with a strong interest and often are engaged in agronomy in Africa interested to know of the lessons important to smallholder impact and able to contribute to the development of a community strategy. The Tropical Legumes community will also host an Oral Session within the Global Agronomy ASA Section. The oral session centers on how present predicament of needing crops globally that can not only feed people and animals but also provide some environmental benefit. Legumes are an important crop for the future due to their ability to fix atmospheric nitrogen. Tropical legumes have ongoing production and societal challenges that are being addressed on many levels. This oral session will address any issue of tropical legumes including breeding and varietal improvement, germplasm adaptation, seed systems, agronomic production, nutrition, utilization, fertility needs, legume value chains, and smallholder access to legumes in the tropics.

- SIL researcher Dr. Dennis Thompson has been integral in promoting the SIL impact through his contributions to Seed World magazine. Distributed six times per year to more than 9,000 seed professionals, each issue of Seed World features a thought-provoking, issues-based look at specific industry concerns as well as regular departments that ensure each reader has a customized experience. The magazine for the U.S. seed industry that delivers real marketing, lead generation and custom media solutions for today’s innovative businesses supplying products and services to this lucrative $12 billion market. With information, advice and ideas covering virtually every business aspect of the U.S. seed market, Seed World is read by owners, presidents and CEOs to help them run and grow their businesses. To date, Dr. Thompson has provided content to Seed World focused on SIL’s role in tropical seed system development, SIL’s development of low-processing soybean lines; SIL research to understand the influence of certain maturity genes in soybean yield, growth and development; SIL’s commitment to developing new, high-yielding and locally-adapted soybean varieties; SIL’s research into soybean uptake and adoption among smallholder women farmers in Mozambique and Ghana, and more. This outreach has had a significant impact on the visibility and awareness of the SIL program and positions SIL to support more practitioner groups internationally seeking to develop soybean.

- In 2016 SIL was invited to host a Track Session at the annual Agricultural & Applied Economics Association (AAEA) meeting in Boston, Massachusetts. The focus of the track session was to explore the topic of the proliferation of soybean in the tropics from four perspectives: production economics, development economics, environmental economics, and agribusiness economics. Soybean also served as a case study to allow analysis of the larger issues of intensification of agriculture in the tropics. The session was moderated by Dr. Robert Bertram, Chief Scientist, Bureau of Food Security, USAID. SIL researchers Dr. Peter Goldsmith, University of Illinois, presented the production economics and Dr. Jill Findeis, University of Missouri, covered development issues. Dr. Michael Coe, Woods Hole Research Center, addressed the
environmental implications, and Dr. Peter Richards, Brown University, presented the agribusiness aspects.

XII) Issues

None at this time

XIII) Future Directions

The Soybean Innovation Lab has a mission to establish the foundations for a sustainable soybean complex in Africa. To that end SIL has focused its efforts in ten management areas that reflect the value chain nature of soybean as a development crop. While we have learned and passed along our findings to our partners, the overarching lesson learned has been that the establishment of a sustainable soybean system in Africa requires transformation across a number of specific fronts.

To this end going forward SIL will be investing in seven critical areas: 1) the soybean breeding and seed production network to assure farmers will have access to high quality and well adapted seed supplies; 2) a Pan-African variety trial system to provide market access for regional seed companies and transparency for the seed trade; 3) small scale mechanization to reduce the labor burden, increase yields, reduce post-harvest losses, and improve grain quality for farmers; 4) assure the availability of high quality and reliable seed, soils, and inoculum testing laboratories to support practitioners promoting soybean development; 5) expand the SMART Farm concept to southern and East Africa to bring high quality reliable production, agronomic, and environmental guidance to farmers; 6) bring business management skills to soy food entrepreneurs to assure the development and proliferation of viable enterprises that support economic development and youth employment; 7) continue longitudinal study of soybean adoption by small holders to better understand the role of soybean as a development crop and its implications for gender equity.

‡‡‡ Such as financial, management, regulatory
Appendices

A. List of awards given to U.S. partners (university, USDA, private sector, etc.) to include project name, dates and funding (current year and total) for each partner.

<table>
<thead>
<tr>
<th>Funding Agency</th>
<th>Title</th>
<th>Funding Year(s)</th>
<th>Total Funding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office of International Programs, College of ACES</td>
<td>Evaluating Plant Breeding Education in Ghana</td>
<td>2015</td>
<td>$5,000</td>
</tr>
<tr>
<td>United States Agency for International Development–</td>
<td>Mentoring Plant Breeders</td>
<td>2016-2018</td>
<td>$850,000</td>
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<tr>
<td>Accra, Ghana</td>
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<td></td>
<td></td>
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<tr>
<td>Office of International Programs, College of ACES</td>
<td>Identification of Soybean Diseases and Pests in Africa: Development</td>
<td>2015</td>
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<tr>
<td></td>
<td>of a Diagnostic Guide</td>
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<td></td>
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<tr>
<td>United States Agency for International Development–</td>
<td>Improving Seed Selection and Storage</td>
<td>2015</td>
<td>$65,000</td>
</tr>
<tr>
<td>Accra, Ghana</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Global Alliance for Improved Nutrition</td>
<td>Technical Support to Winnua Lda (Mozambique) for Soy Yoghurt</td>
<td>2016</td>
<td>$14,620</td>
</tr>
<tr>
<td></td>
<td>development, Market Study, Investment Plan &amp; Business Plan development</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agricultural Technology Transfer (ATT) and ADVANCE</td>
<td>Tamale Implement Factory blacksmith training for smallholder</td>
<td>2016</td>
<td>$9,549</td>
</tr>
<tr>
<td>Projects</td>
<td>thresher production</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Church of the Brethren</td>
<td>SMART Farm Outreach for Church of the Brethren Nigeria &amp; Liberia</td>
<td>2016</td>
<td>$8,664</td>
</tr>
<tr>
<td></td>
<td>Delegations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>World Bank</td>
<td>Aquaculture and Fisheries Science (Aqua Fish) Centre of Excellence</td>
<td>2016-2019</td>
<td>$138,865</td>
</tr>
</tbody>
</table>

B. Three distinct success stories

§§§ Each should: a) be limited to 500 words, b) be results oriented, c) written in layman’s terms, d) avoid acronyms, e) address Feed the Future priorities, and f) include a high resolution digital photo with caption and photo credit. It is okay to reference a website for more detailed information.
Success Story 1: Finding the best seeds to match Africa’s needs

Soybean farmers in the United States can choose from a “candy store” of hundreds of varieties of soybean seed—high-yielding seed with proven performance traits for every region and latitude. Soybean farmers in Africa may either only have access to a few seed varieties with an unimpressive yield potential, or a few high-yielding varieties for which no performance data exists for their latitude and altitude. A new coordinated soybean variety evaluation program is underway that will address these problems and give African growers more and better seed options.

“An important component to establishing a foundation for soybean in Africa is having a third-party trial program. It’s vital to have independent confirmation about varieties, yield, adaptation to a particular area, yield performance in area A versus B, and disease resistance,” says Peter Goldsmith, University of Illinois economist and principal investigator of USAID’s Soybean Innovation Lab (SIL). “Through a partnership with the African Agricultural Technology Foundation and the Syngenta Foundation for Sustainable Agriculture, which operates independently from its parent company, we are transforming the process of soybean seed production by introducing the concept of variety testing.”

Goldsmith explained that the Syngenta Foundation for Sustainable Agriculture has extensive experience running variety and input trials across Africa. “They have test plots and protocols, and managers to make sure everything is done consistently. Planting soybean trials at those same locations saves time and money.”

“Varietal testing is a necessary piece of the process of assuring high quality seed is available to farmers, and in turn that allows farmers to be productive and profitable, which leads to reduced levels of poverty and malnutrition,” says Goldsmith. “You don’t always know if the yield response was due to genetics, seed quality, agronomics, or just the wrong seed for that particular location. Varietal testing addresses that by testing a set of varieties in numerous locations. Soybean seed is very sensitive to both latitude and altitude so this kind of varietal testing gives objective, third-party assessment of the yield, disease resistance, etc.”

University of Illinois soybean geneticist Brian Diers and USDA-ARS geneticist Randy Nelson are working with the Syngenta Foundation on this project.

“Collecting and distributing unbiased variety testing results will be important as soybean production increases in Africa,” says Diers. “Only through testing varieties together in field trials do we know which varieties have the best potential to help African farmers generate income that will help them out of poverty.”

Goldsmith says the Feed the Future Soybean Innovation Lab is looking at all of the pieces of the puzzle—breeder training, breeder equipment, capacity, ability to obtain and properly handle seed material, and the ability to test the varieties. “It’s like a pipeline with the farmer at the end of a long seed development and commercialization process. Without good varietal performance information breeders, multipliers, seed companies, and of course farmers do not have the information to make informed decisions. Varietal testing addresses that problem.”

“Having a public/private partnership is unique,” Goldsmith says. “To work with the Syngenta Foundation for sustainable agriculture on a common objective, we combine University of Illinois science with their development objectives. This kind of trans-border seed movement can be complicated. Syngenta Foundation has done all of the local regulatory work, such as how to bring seed into the country. They have their own network through the donor community and private sector seed growers with their program called Seed2B (seed to business). It’s educating African soybean breeders and growers about why trials and third-party information is important in countries that have had little varietal improvement thus far.”

Goldsmith says that since SIL began two years ago numerous soybean breeders and public and private seed organizations have come forward seeking to benefit from SIL’s breeder development and
varietal testing programs. Although current funds are allocated, SIL and the Syngenta Foundation are actively looking for new sources of donor and private sector funding to expand the in Africa.

Caption: Seeing is Believing: Participants including soybean farmers, breeders, seed companies, processors, NARS researchers, government agencies, NGOs, inoculum producers, farmer cooperatives, CGIAR institutions and more joined together at the Thika Practical Training Centre in Kenya to assess and benchmark first-hand the performance, adaptability and market acceptance of 23 tropically-adapted soybean varieties. (Photo Credit: Peter Goldsmith)
Success Story 2: Thresher Training Builds Entrepreneurship and Brings Needed Low-Cost Mechanization

Like many countries in Sub-Saharan Africa, Ghana lacks the availability and development of low-cost, locally-produced harvest technologies like crop threshers. Unfortunately, the threshers available in the market are imported machines which are too big and expensive to fit the needs of smallholder farmers. Most smallholder farmers still pull dry mature plants by hand and then hand thresh to separate the grain from the pods. The work is difficult and time consuming, the grain losses are high and the resulting grain quality is poor.

Dr. Kerry Clark, SIL researcher, recognized that low cost, small scale, locally produced threshers could provide a solution to harvest crops like soybean. In August 2016, the Soybean Innovation Lab (SIL) and Catholic Relief Services (CRS) held an eight-day training to teach 12 local blacksmiths and workers at the Tamale Implement Factory how to fabricate small-scale crop threshers for use in Northern Ghana. The blacksmiths learned not only how to fabricate the threshers, but received business training, and constructed three working threshing machines which will be distributed to three villages in Northern Ghana.

SIL saw several issues around the availability and usage of harvest technology in Ghana. First was that the threshers available in the market are all imports and too large and expensive (several thousand U.S. dollars) for smallholder farmers. We often see these threshers broken down and unused as well. The design on many of these imports is not user-friendly; the inside of the machine is not easily accessible if there are problems, such as a jammed threshing cylinder. We doubt that there was any usage or maintenance training that accompanied these threshers. If people are not making purchases of agricultural equipment locally, then there is also likely no local contact for continued repair of the machine. Also, most imported threshers are ones designed for maize. Soybean, small grains and pulse crops are extremely underserved in available harvest technologies in Ghana.

The goal was to design and build a small, durable and inexpensive thresher that is appropriate for small-scale soybean production (~1-2 acres). We also thought it was vital that fabrication be a local industry in order to have local and ongoing oversight of equipment functionality and repairs. Businesses that build equipment have a vested interest in making sure that the equipment is used properly, has a long, functional life and is appropriately designed for customer needs. We believe that by training local welders to manufacture these threshers, we increase the interest level and the exposure to the technology and we make it less likely that they will quickly break down and be forgotten. Local production gives the end-user someone to talk to when there are problems or someone to bring the machine to when it needs repairs. A local fabricator will be more motivated to get his product fixed and back in the field than he might for a thresher that was imported. The local fabricator also has a more detailed knowledge of the design of a thresher he has fabricated and is more likely to be able to fix it than equipment he is not familiar with or which might have parts that cannot be found locally.

Funding for the training was provided by the Agricultural Development and Value Chain Enhancement (ADVANCE) project and funding for the fabrication materials came from the Feed the Future Ghana Agriculture Technology Transfer (ATT) project. Gabriel Abdulai, an agricultural engineer at the Savanna Agricultural Research Institute (SARI), who designed and conducted the training is developing design books and a training module for organizations interested in creating similar workshops and is collaborating with SIL to build an international thresher design network.
Caption: Blacksmiths from the Upper East region of Ghana built this bicycle powered thresher designed by Gabriel, agricultural engineer at the Savanna Agricultural Research Institute (SARI), during the eight-day training at the Tamale Implement Factory in Tamale, Ghana. This thresher will be distributed to a village in the Upper East region of Ghana. (Photo Credit: Kerry Clark)
Success Story 3: Appropriate Agronomics Dramatically Increase Soybean Yields

Soybean Innovation Lab (SIL) research shows that when combining appropriate agronomic practices, soybean yields using locally available varieties can be increased over 2.5 times what farmers commonly experience in Northern Ghana. These agronomic practices include planting date, row spacing, seed spacing, and seed population with appropriate inputs, like phosphorus and inoculum.

This guidance stems from two years of evidence-based data generated at the SIL SMART Farm (Soybean Management with Appropriate Research & Technology) located at the Savanna Agricultural Research Institute (SARI) in Northern Ghana. The SMART Farm provides consistent, reliable and scientific agronomic recommendations for smallholder farmers producing soybean in Ghana. Knowledge generated from the research farm equips contractors, extensionists, agronomists and the government with the technical guidance they need to make their farmer groups successful soybean producers.

The SMART Farm Manager, Dr. George Awuni, is beginning his third year of trials in collaboration with SARI. Dr. Awuni will stagger his planting over the following weeks to provide valuable data on how planting date relates to soybean yield. The SMART Farm locations are at three SARI locations at Nyankpala in the Northern Region, Manga in the Upper East Region, and Bamahu in the Upper West Region. The SMART Farm model reflects the criticality of rigorous controls, replication and extension partnerships to assure practitioners and farmers have access to high quality and reliable agronomic and production guidance. The SMART Farm Model also recognizes the local nature of soybean performance with multiple on-station and matched on-farm trial sites.

The SMART concept adopts a holistic approach confronting soybean production from soil fertility, seed germination, planting and nutrient stewardship, and other agronomic practices through to harvest. Results obtained are intended to provide stakeholders in the soybean production system with additional information to improve yields. Results from the first two years of SMART Farm research show that Nyanakpala soils were classified as loamy sand and clay loam for surface and subsoils, respectively. Manga soils were of loamy sand and sandy loam soils, while at Bamahu the soils were classified as loam. Soil pH ranged from moderately acid at Nyankpala and Bamahu sites to strongly acid at Manga. Soil nutrient fertility rated across all 3 locations ranged mostly from very low to medium depending on nutrient element tested. Calculated cation exchange capacity was very low for Manga soils compared to Nyankpala and Bamahu. Lime and specific nutrient amendment recommendation were made for each location.

Seed germination percentage depended on year and variety tested. However overall germination percentage was higher in 2015 than in 2014. In the nutrient amendment trial, average yield of varieties across nutrient amendment was not significant for the 2 cropping seasons. The synergy of soybean inoculation and phosphorus (+I+P) application resulted in significant yield averaged across varieties. In the variety trial, average yields of varieties across locations was not significant in 2014. However, in 2015 varietal yield was depended on location. The planting date trial, varieties yields averages across planting dates was significant as well as planting date yield averaged across varieties in both seasons. Plots planted within the first week of July resulted in higher yields compared to late planting. These experiments will be repeated and expanded to other locations.
Caption: SMART Farm Manager Dr. George Awuni explains the effects of inoculum and phosphorous application on local soybean varieties to attendees of the 2nd annual Soybean Kick-off Event held in Wa, Ghana in October 2016. Dr. Awuni’s research has shown that with the application of both inoculum and phosphorous locally available Ghanaian soybean varieties can achieve yields that surpass 2,500kg/ha. (Photo Credit: Courtney Tamimie)