

# 2020

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## ANNUAL PERFORMANCE REPORT



Innovation Lab for Collaborative  
Research on Sustainable Intensification

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*transforming farming systems for smallholders*

# Feed the Future Innovation Lab for Collaborative Research on Sustainable Intensification

*Annual Performance Report FY 2020*

This annual performance report for FY 2020 is made possible by the generous support of the American people through the United States Agency for International Development (USAID). The contents are the responsibility of Kansas State University and do not necessarily reflect the views of USAID or the United States Government.

Program activities are funded by the United States Agency for International Development under Cooperative Agreement No. AID-OAA-L-14-00006.

## Cover Photos

Top Left: Introduction of climate resilient and nutritious rice to farmers in collaboration with STRASA and HarvestPlus project in Khulna, Bangladesh. Photo credit: Krishna Jagdish. June 2016.

Top Right: Taken of a local woman farmer in Tanzania. Photo credit: Molly Web. June 2016.

Bottom Left: Local blacksmiths learned to build in-line subsoilers for conservation tillage at a training session at the Kolumbia Innovation Hub. Photo credit: Timothy Harrigan. May 2018.

Bottom Right: Siem Reap farmers show off their Wild Gardens and discuss medicinal qualities and market value of individual species in Cambodia. Photo credit: Ricky Bates. February 2020.



## Management Entity Information

The Feed the Future Innovation Lab for Collaborative Research on Sustainable Intensification (SIIL) is housed at Kansas State University in Manhattan, KS. The management entity staff includes the following individuals:



### **Dr. P.V. Vara Prasad – Director**

Email: [vara@k-state.edu](mailto:vara@k-state.edu)

Vara Prasad, University Distinguished Professor of Crop Ecophysiology, serves as the Program Director of SIIL. He earned his B.S. and M.S. in agronomy from Andhra Pradesh Agricultural University in India, and his Ph.D. in crop physiology from The University of Reading in England. He has extensive international experience in both Africa and Asia and has had significant involvement with several USAID projects in these regions. His research focuses on understanding the response of food-grain crops to changing environments and management practices; developing strategies for management of crops, soil, water and nutrients for the efficient use of resources; and using farming-system approaches to provide food and nutritional security to smallholder farmers. Prasad provides leadership to SIIL and oversees all of the research, capacity building, knowledge sharing and communication activities of the program. He administers technical and financial aspects of SIIL and serves as the primary contact for donors, advisory groups and partner organizations.



### **Dr. B. Jan Middendorf – Associate Director**

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B. Jan Middendorf serves as the Associate Director for Feed the Future Innovation Lab for Collaborative Research on Sustainable Intensification (SIIL) at Kansas State University (KSU). As Associate Director, Dr. Middendorf conducts research and leads SIIL's impact assessment and monitoring and evaluation efforts. She is also responsible for establishing and maintaining effective partnerships with other U.S. and international institutions, industry, USAID Missions and developmental partners. As part of these efforts, she develops and implements strategic planning and capacity building initiatives to enhance collaborative research and support organizational change. This experience includes working with various stakeholders at the community, regional, national and international levels. Prior to this role, Dr. Middendorf managed a \$15.5M diverse portfolio as Program Director of Project and Program Evaluation in the Directorate for Education and Human Resources (EHR) for the National Science Foundation (NSF). She also served for ten years as director of an evaluation center at KSU. Dr. Middendorf has over 25 years of experience in project development, management, implementation and evaluation of multi-institutional, interdisciplinary programs and projects in national and international settings. Dr. Middendorf earned her Ph.D. from KSU after completing her Master's and Bachelor's from Ohio University and University of Rhode Island, respectively.





### **Dr. Manny Reyes – Research Professor**

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Manuel Reyes, Research Professor, has more than 30 years of experience working with water quality modeling, natural resources management and conservation agriculture. He is an agroecological engineer, designing food production systems that mimic nature. Reyes has extensive expertise across the globe in research, extension, teaching and project implementation. Reyes has focused his efforts in Cambodia, working with the Royal University of Agriculture and University of Battambang to enhance human and institutional capacity to conduct research and training of scholars and youth, as well as helping to lead the Center of Excellence on Sustainable Agricultural Intensification and Nutrition (CE SAIN). He has facilitated partnerships with other Feed the Future Innovation Labs, international organizations and NGOs, local non-profits, and private industry in Cambodia.



### **Dr. Zachary Stewart – Assistant Research Professor**

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Zach Stewart serves as the SIIL Research Assistant Professor and Program Manager. He leads SIIL's research activities in international soil and cropping systems with a particular focus on linking agricultural production to improved human nutrition and livelihoods. Dr. Stewart also serves as the Program Manager for the “SOILS Consortium” with the vision to improve the health and fertility of soils as the foundation for nutritious food production and resilient and sustainable livelihoods. This vision is implemented through innovative research, coordination, capacity building, networking, data sharing, and communication approaches. He earned his B.S. in Biology, Environmental Sciences, and International Relations from Creighton University, his M.S. in Control of Infectious Diseases from the London School of Hygiene and Tropical Medicine, and his Ph.D. in Soil Science and Crop Physiology from the University of Nebraska. He has led extensive research across sub-Saharan Africa and Southeast Asia on agronomic and human health topics. As the 2008 recipient of the John Chrystal Award from

the World Food Prize Foundation, Dr. Stewart has been able to use his multidisciplinary background to leverage agriculture as the means to improve smallholder farmer livelihoods. As part of the SIIL management entity, Dr. Stewart has a lead role in the development and implementation of the [Sustainable Intensification Assessment Framework](#).



### **Andra Williams – Program Administrator**

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Andra Williams serves as the Program Administrator for the SIIL. She collaborates with the Lab's domestic and international partners to help manage the program's monitoring and evaluation, communication, reporting, and knowledge management needs. Andra received a B.A. in French, with a minor in Community Nutrition, from the University of California, Davis, and a Master's in International Development and Sustainability from the Université Grenoble-Alpes in France. She served as a Peace Corps health volunteer in Senegal from 2013-2014 and has worked in both Senegal and Guinea as a part of USAID projects. Andra was most recently employed with the Horticulture Innovation Lab at UC Davis prior to coming to the SIIL. She speaks fluent French and passable Seerer.



### **Jessica Burden – Business Manager**

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Jessica Burden serves as the Business Manager for the Sustainable Intensification Innovation Lab. She is responsible for the financial management of all grants, including post-award accounting, travel planning, distribution of funding for sub-awards, and working with pre- and post-award services. Jessica holds a B.S. in Business Administration – Accounting with a minor in Leadership Studies, as well as a Masters in Accountancy, both from Kansas State University. Additionally, she has previous experience as an auditor, providing her with much grant compliance and financial experience and prior university experience at Kansas State, Oklahoma State, and University of North Texas.



### **Layne Wilson – Communications Specialist**

*Email:* [laynewilson@ksu.edu](mailto:laynewilson@ksu.edu)

Layne Wilson serves as the International Communications Specialist for the Sustainable Intensification Innovation Lab. She is responsible for developing and implementing communication strategies, success stories and social media content from project activities for effective outreach. Layne graduated from Texas Tech University with a Bachelor of Science in Agricultural Communications and a minor in Agribusiness Management.



### **Dr. Aliou Faye – iREACH Initiative and Country Coordinator, Senegal**

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Aliou Faye has two decades of research experience with the Senegalese Agricultural Research Institute (ISRA), the French Institute of Research for Development and the International Centre for Cooperation in Agricultural Development (CIRAD). Faye worked also for 5 years as Chief of Agency of a Saudi group dealing with non-timber forest products in the Tambacounda and Louga regions of Senegal. Faye holds a B.S. in Tropical Forestry, a M.S. in Agronomy, and a Ph.D. in Plant Biology from the Cheikh Anta Diop University of Dakar with field experience at the Tropical Soil Biology and Fertility (CIAT) in Nairobi Kenya. Faye has published at least 20 research articles in different scientific journals. Dr. Faye is currently the head of the Soil-Water and Plant Laboratory of the Centre National de la Recherche Agronomique (CNRA) of ISRA in Bambey, Senegal and serves as the iREACH Initiative and Country Coordinator for the SIIL in Senegal.



**Dr. Hamidou Traore – Country Coordinator, Burkina Faso**

Email: [hamitraore8@yahoo.com](mailto:hamitraore8@yahoo.com)

Dr. Hamidou Traore has over 25 years of research experience in the field of agronomy. Dr. Traore holds a PhD in Weed Science from the University of Montpellier II, Sciences and Techniques of Languedoc, France, and a Diploma of Rural Development Engineering in Agronomy from University of Ouagadougou. Dr. Traore currently serves as Director of Institut de l'Environnement et de Recherche Agricoles (INERA), Burkina Faso. He previously held the position of Regional Director of the Eastern and Sahelian Environmental and Agricultural Research Regional Centers. Dr. Traore was also a Fulbright Scholar at the Agronomy Department of Purdue University.



**Araya Berhe – Research Associate**

Email: [aberhe@ksu.edu](mailto:aberhe@ksu.edu)

Araya Berhe serves as a Research Associate in the Department of Agronomy and the Sustainable Intensification Innovation Lab (SIIL). He received his Ph.D. in Production Ecology and Resources Conservation from Wageningen University, the Netherlands. Currently, his research is focused on the application of crop modeling, geospatial and agro-meteorological techniques for sustainable water management, developing climate change adaptation and resilience strategies, and optimizing resources use for sustainable agricultural production and food security. Addressing water shortage, climate change and climate variability, and nutrient management related challenges in agriculture at local, regional and global level are some of his main research interest.



**Prakash Kumar Jha – Postdoctoral Fellow**

Email: [pjha@ksu.edu](mailto:pjha@ksu.edu)

Prakash Kumar Jha is a postdoctoral fellow at the College of Agriculture at Kansas State University and works in collaboration with the SIIL. He earned his B.S. in Agricultural Sciences from Banaras Hindu University, India, his M.S. in Environmental Sciences from Indian Agricultural Research Institute, India, and his Ph.D. in Crop and Soil Sciences from Michigan State University, USA. Prakash is currently engaged in the projects on Lonsinger Sustainability Research Farm, and supports some activities of the Geospatial and Farming Systems Research Consortium (GFC) at Kansas State University.



## External Advisory Board

The External Advisory Board (EAB) is chaired by Jules Pretty. The EAB was actively engaged in evaluating the proposals for focus country research subawards and was responsible for making final decisions on project selection.



### **Professor Jules Pretty – Chair**

*University of Essex*

Prof. Jules Pretty is Deputy Vice-Chancellor at the University of Essex, and Professor of Environment and Society. His 18 books include *This Luminous Coast* (2011), *Nature and Culture* (2010), *The Earth Only Endures* (2007), and *Agri-Culture* (2002). He is a Fellow of the Society of Biology and the Royal Society of Arts, former Deputy-Chair of the government's Advisory Committee on Releases to the Environment, and has served on advisory committees for a number of government departments and research councils. He was a member of two Royal Society working groups that published *Reaping the Benefits* (2009) and *People and the Planet* (2012), and was a member of the UK government Foresight project on *Global Food and Farming Futures* (2011). He is the founding Chief Editor of the *International Journal of Agricultural Sustainability*. He received an OBE in 2006 for services to sustainable agriculture, and an honorary degree from Ohio State University in 2009. More details can be found at [www.julespretty.com](http://www.julespretty.com).



### **Dr. John Dixon**

*Australian Centre for International Agricultural Research - retired*

Dr. Dixon has over 30 years developing country experience with agricultural research and development, including cropping systems, economics and natural resource management in South, South-east and East Asia, Africa, Latin America and the Middle East, working for the CGIAR system and the FAO. He has served as Director, Impacts, Targeting and Assessment at CIMMYT, leading activities on impact assessment, value chains, impact knowledge sharing, systems agronomy and conservation agriculture; and also in various capacities with FAO in their global, regional and country programs. He also led ACIAR international program and is currently and Adjunct Professor at Queensland Alliance for Agriculture and Food Innovation, The University of Queensland. Dr. Dixon is a graduate from the University of New England with a Ph.D. (agricultural economics), Masters (natural resources), Masters (economics) and Bachelor in Rural Science.



### **Dr. Cornelia Flora**

*Iowa State University*

Dr. Cornelia Flora is an Emeritus Distinguished Professor in the Department of Sociology at Iowa State University. Her research interests include international and domestic development, community, and the sociology of science and technology, particularly as related to agriculture and participatory change. Socio-technical regime changes and capitals transformations (natural, cultural, human, social, political and financial/built capitals) guide her current research includes work on the community development, sustainable agriculture and natural resource management, with particular attention to how class, gender, and ethnicity influence and are influenced by technology and policy.



### **Dr. Peter Thorne**

*International Livestock Research Institute (ILRI) - retired*

Dr. Peter Thorne coordinates the Africa RISING project in the Ethiopian Highlands. He completed his Ph.D. at the University of Nottingham in animal nutrition, with a part of his research conducted at the University of the Philippines in Los Banos. His career has allowed him to work in both public and private sectors, focusing largely on the evolution of mixed farming systems in Africa and Asia. Prior to joining ILRI, Dr. Thorne was responsible for the national dairy benchmarking service in Britain.



### **Dr. Deborah Bossio (2014-2019)**

*The Nature Conservancy*

Dr. Deborah Bossio is the Lead Soil Scientist for The Nature Conservancy, where she is an integral member of the Global Lands team and an active member of the [Science Cabinet](#), a collaborative group of Conservancy Lead Scientists contributing topical expertise to cross-cutting science issues for the organization. In this role she integrates new soil science expertise to support and advance existing climate, agriculture, forestry and conservation priorities and to better understand how we can scale our impact through improved soil management.



### **Dr. Jemimah Njuki (2014-2019)**

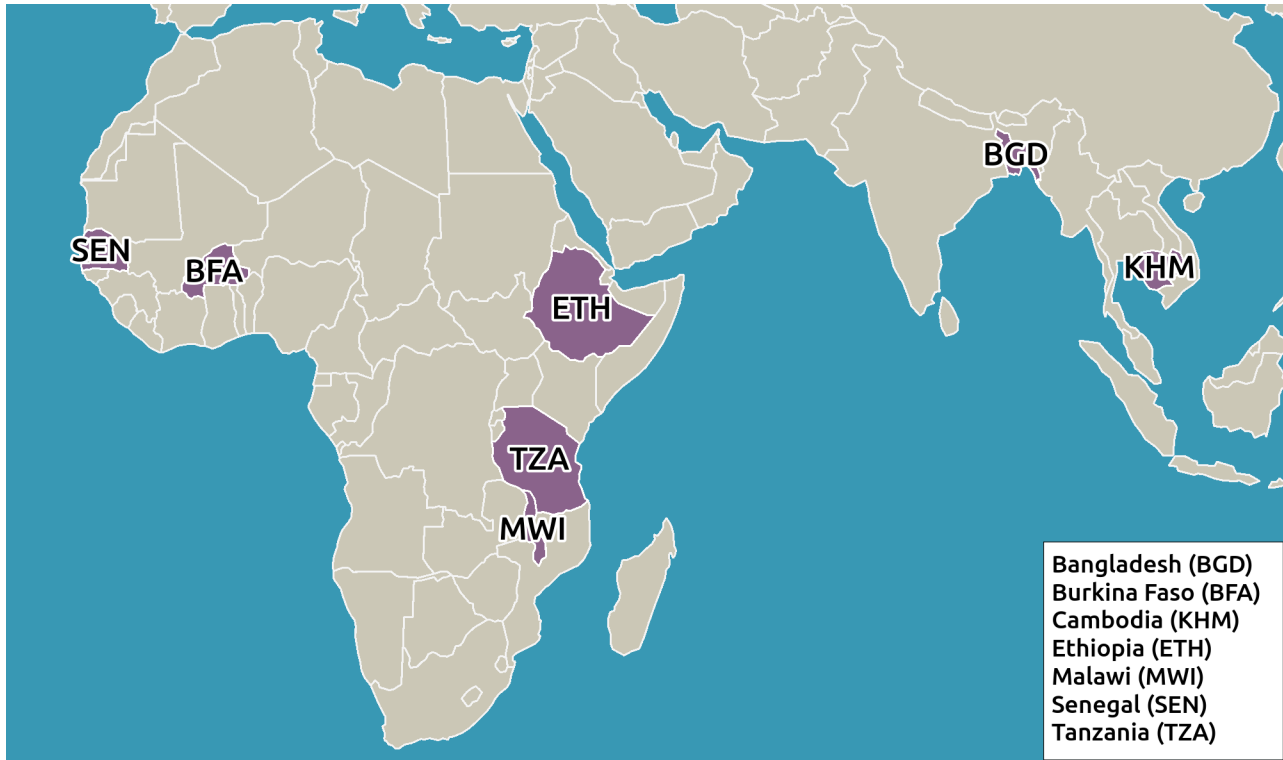
*Canada's International Development Research Center (IDRC)*

Dr. Jemimah Njuki has fifteen years of experience overseeing gender-responsive and women-targeted research and development projects that link women smallholder farmers to markets, integrate gender in cooperatives, apply participatory gender-responsive research, and more. As senior program officer at the International Development Research Centre (IDRC), she manages the Cultivate Africa's Future program.



## Focus Countries

The Feed the Future Innovation Lab for Collaborative Research on Sustainable Intensification works in West Africa, East Africa and Asia. The six focus countries are listed and shown below, along with the Malawi Subaward that was initiated in FY 2017 and completed in FY 2019.



## List of Program Partners

### United States

ADM Institute for the Prevention of Postharvest Loss  
 American Soybean Association (ASA)  
 Feed the Future Innovation Lab for Collaborative Research on Nutrition  
 Feed the Future Innovation Lab for Horticulture  
 Feed the Future Innovation Lab for Small Scale Irrigation  
 Feed the Future Innovation Lab for the Reduction of Postharvest Loss  
 Kansas State University (KSU)  
 Michigan State University (MSU)  
 Montana State University  
 North Carolina A&T State University (NCA&T)  
 Northwestern University  
 Oakland University  
 Pennsylvania State University  
 Stanford University  
 Texas A&M University (TAMU)  
 Tillers International  
 Tufts University  
 United States Peace Corps - Senegal  
 University of California, Davis (UC-Davis)  
 University of Colorado - Boulder  
 University of Florida (UF)  
 University of Illinois at Urbana-Champaign  
 University of Maryland  
 University of Minnesota  
 University of Tennessee Institute of Agriculture (UTIA)  
 University of Wisconsin – Madison

### Bangladesh

ACI Motors Limited  
 Bangladesh Agricultural Research Council (BARC)  
 Bangladesh Agricultural Research Institute (BARI).  
 Bangladesh Agricultural University (BAU)  
 Bangladesh Rice Research Institute (BRRI)  
 BRAC  
 International Maize and Wheat Improvement Center (CIMMYT)  
 International Rice Research Institute (IRRI)  
 Khulna University

### Burkina Faso

Association pour la Promotion de l'Élevage en Savane et au Sahel (APESS)  
 Institut de l'Environnement et de Recherches Agricoles (INERA)  
 International Livestock Research Institute (ILRI)  
 La Fédération Nationale des Groupements Naam (FNGN)  
 Polytechnic University of Bobo-Dioulasso (UPD)  
 The International Union for Conservation of Nature (IUCN)

Cambodia

Agricultural Development Denmark Asia (ADDA)  
 AVRDC – World Vegetable Center  
 Conservation Agriculture Service Center (CASC)  
 Centre de Coopération Internationale en Recherche Agronomique pour le Développement (CIRAD)  
 Department of Agricultural Engineering (DAEng)  
 ECHO Asia  
 Institute of Technology of Cambodia (ICT)  
 Kasetsart University  
 Ministry of Agriculture Forestry and Fisheries (MAFF)  
 Ministry of Education and Youth (MoEY)  
 Royal University of Agriculture - Phnom Penh (RUA)  
 University of Battambang (UBB)

Ethiopia

Africa Research in Sustainable Intensification for the Next Generation (Africa RISING)  
 Bahir Dar University / Bahir Dar Institute of Technology  
 International Food Policy Research Institute (IFPRI)  
 International Livestock Research Institute (ILRI)  
 International Water Management Institute (IWMI)  
 University of Twente

Senegal

Agence Nationale de Conseil Agricole et Rural (ANCAR)  
 Bureau d'Analyse Macro Economiques (BAME)  
 Centre de Coopération Internationale en Recherche Agronomique pour le Développement (CIRAD)  
 Institut de Recherche Pour le Développement (IRD)  
 Institut de Technologie Alimentaire (ITA)  
 Institut Sénégalais de Recherches Agricoles (ISRA) – Centre National de Recherches Agronomiques de Bambey (CNRA – Bambey)  
 ISRA - Laboratoire National d'Élevage et de Recherches Vétérinaire (LNERV)  
 ISRA - Laboratoire National de Recherche sur les Production Végétales (LNRPV)  
 Réseau des Organisations Paysannes et Pastorales du Sénégal (RESOPP)  
 University of Thies – College of Agriculture

Tanzania

Africa Research in Sustainable Intensification for the Next Generation (Africa – RISING)  
 International Center for Tropical Agriculture (CIAT)  
 International Institute of Tropical Agriculture (IITA)  
 International Maize and Wheat Improvement Center (CIMMYT)  
 N2Africa  
 Nelson Mandela African Institution of Science and Technology (NM-AIST)  
 Sokoine University of Agriculture (SUA)

Additional Partners or Collaborators

African Economic Research Center (AERC)  
 American Soybean Association (ASA)  
 aWhere  
 Conseil Ouest et Centre Africain pour la Recherche et le Développement Agricoles (CORAF)  
 Corteva Agriscience  
 Descartes Labs



Innovation Research, Extension, and Advisory Coordination Hub (iREACH)  
International Fertilizer Development Center (IFDC)  
International Institute for Applied Systems Analysis (IIASA)  
ITC – Netherlands  
Kifiya Financial Technology Plc.  
One Acre Fund  
Quantitative Engineering Design  
Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA)  
Swiss Federal Institute of Aquatic Science and Technology (EAWAG)  
Swisscontact  
Taking Maize Agronomy to Scale in Africa (TAMASA)  
University of Gaston-Berger  
University of Rwanda  
Wageningen University and Research Center  
World Agroforestry Center  
World Vision

## Acronyms

ACIAR – Australian Centre for International Agricultural Research  
 ADDA – Agricultural Development Denmark Asia  
 ADS – Automated Directives System  
 AERC – African Economic Research Center  
 Africa RISING – Africa Research in Sustainable Intensification for the Next Generation  
 AfSIS – Africa Soil Information Service  
 AGRA – Alliance for a Green Revolution in Africa  
 ANCAR – Agence Nationale de Conseil Agricole et Rural  
 AOR – Agreement Officer’s Representative  
 APSS – Association pour la Promotion de l’Elevage en Savane et au Sahel  
 ASA – American Soybean Association  
 ASM – Appropriate scale mechanization  
 ASMC – Appropriate Scale Mechanization Consortium  
 AUC – African Union Commission  
 AWP – Annual Work Plan  
 BAME – Bureau d’Analyse Macro Economiques  
 BARC – Bangladesh Agricultural Research Council  
 BARI – Bangladesh Agricultural Research Institute  
 CA – Conservation Agriculture  
 CASC – Conservation Agriculture Service Center  
 CASF – Conservation Agriculture Service with a Fee  
 CAST – Commercialization of Aquaculture for Sustainable Trade  
 CE SAIN – Center of Excellence on Sustainable Agricultural Intensification and Nutrition  
 CGIAR – Consultative Group on International Agricultural Research  
 CIAT – International Center for Tropical Agriculture  
 CIMMYT – International Maize and Wheat Improvement Center  
 CIRAD – Centre de Coopération Internationale en Recherche Agronomique pour le Développement  
 CNRA – Centre National de Recherches Agronomiques (CNRA)  
 CORAF – Conseil Ouest et Centre Africain pour la Recherche et le Développement Agricoles  
 CSA – Climate smart agriculture  
 CSIRO – Commonwealth Scientific and Industrial Research Organisation  
 DAEng – Department of Agricultural Engineering  
 DDL – Data Development Library  
 EAB – External Advisory Board  
 EMMP – Environmental Management and Mitigation Plan  
 EAWAG – Swiss Federal Institute of Aquatic Science and Technology  
 FAA – Federal Aviation Administration  
 FABE – Faculty of Agricultural Biosystems Engineering  
 FAO – Food and Agriculture Organization  
 FGD – Focus Group Discussions  
 FNGN – La Fédération Nationale des Groupements Naam  
 FLMLA – Faculty of Land Management and Land Administration  
 FTFMS – Feed the Future Monitoring System  
 FY – Fiscal year  
 GFC – Geospatial and Farming Systems Research Consortium  
 GIS – Geographic Information System  
 GMCC – Green Manure Cover Crops  
 HYV – High Yielding Varieties  
 ICRISAT – International Crops Research Institute for the Semi-Arid Tropics  
 ICT – Institute of Technology of Cambodia

IDRC – International Development Research Centre  
 IDSS – Integrated Decision Support System  
 IFDC – International Fertilizer Development Center  
 IFPRI – International Food Policy Research Institute  
 IIASA – International Institute for Applied Systems Analysis  
 IITA – International Institute of Tropical Agriculture  
 IL – Innovation Lab  
 ILRI – International Livestock Research Institute  
 ILSSI – Innovation Lab for Small Scale Irrigation  
 INERA – Institut de l’Environnement et de Recherches Agricoles de Burkina Faso  
 INGENAES - Integrating Gender and Nutrition within Agricultural Extension Services  
 INRAN – Institut National de la Recherche Agronomique du Niger  
 IPM – Integrated Pest Management  
 iREACH – Innovation Research, Extension, and Advisory Coordination Hub  
 IRD – Institut de Recherche Pour le Développement  
 IRRRI – International Rice Research Institute  
 ISRA – Institut Sénégalais de Recherches Agricoles  
 ITA – Institut de Technologie Alimentaire  
 IUCN – International Union for Conservation of Nature  
 IWMI – International Water Management Institute  
 LIVES – Livestock and Irrigation Value Chains for Ethiopian Smallholders  
 LNERV – Laboratoire National d’Élevage et de Recherches Vétérinaire  
 LNRPV – Laboratoire National de Recherche sur les Production Végétales (LNRPV)  
 MAFF – Ministry of Agriculture Forestry and Fisheries  
 ME – Management Entity  
 MoEY – Ministry of Education and Youth  
 MOU – Memorandum of Understanding  
 MSU – Michigan State University  
 NARS – National Agricultural Research Systems  
 NGO – Nongovernmental organization  
 NM-AIST – Nelson Mandela African Institution of Science and Technology  
 NUS – Neglected and underutilized species  
 PRC – Policy Research Consortium  
 PI – Principal investigator  
 PTOS – Power Tiller Operated System  
 R4D – Research for Development  
 RESOPP – Réseau des Organisations Paysannes et Pastorales du Senegal  
 RHoMIS – Rural Household Multiple Indicator Survey  
 RUA – Royal University of Agriculture  
 SAR – Synthetic Aperture Radar  
 SBIR – Small Business Innovation Research  
 SEARCA – Southeast Asian Regional Center for Graduate Study and Research in Agriculture  
 SI – Sustainable intensification  
 SIIL – Sustainable Intensification Innovation Lab  
 SIPS – Sustainably intensified production systems  
 SSA – Sub-Saharan Africa  
 SUA – Sokoine University of Agriculture  
 TAMASA – Taking Maize Agronomy to Scale in Africa  
 TP – Technology Park  
 UAV – Unmanned Aerial Vehicle  
 UBB – University of Battambang  
 UPB – Polytechnic University of Bobo-Dioulasso



USAID – United States Agency for International Development  
USG – United States Government  
UTIA – University of Tennessee Institute of Agriculture  
WAgN – Women in Agriculture Network



## Table of Contents

Management Entity Information .....	iii
External Advisory Board.....	vii
Focus Countries.....	ix
List of Program Partners.....	x
Acronyms .....	xiii
I. Executive Summary.....	19
II. Focus Country Key Accomplishments.....	20
Bangladesh .....	20
I. ASMC 1:.....	20
II. ASMC 2:.....	20
III. Unlocking the Production Potential of Polder Communities in Coastal Bangladesh (2016-2020):.....	20
IV. Pathways of Scaling Agricultural Innovations for Sustainable Intensification in the Polders of Coastal Bangladesh.....	20
Burkina Faso.....	21
V. ASMC 1:.....	21
Cambodia.....	21
VI. ASMC 1:.....	21
VII. ASMC 2:.....	21
VIII. Women in Agriculture Network (WAgN) (2016-2020):.....	21
IX. S3 Cambodia – Scaling Suitable Sustainable Technologies: .....	22
Ethiopia.....	22
X. ASMC 1:.....	22
Senegal.....	23
XI. Adoption of Sustainable Intensification in Dual-Purpose Millet-Leguminous Crops-Livestock Systems to Improve Food and Nutritional Security and Natural Resources Management for Rural Small Holder Farmers in Senegal (2016-2020):.....	23
XII. Improving Food and Nutrition Security of Smallholder Agro-Pastoral Farming Systems by Integrating Crop-Livestock-Human Nutrition in Senegal and Niger:.....	23
Tanzania .....	24
XIII. Raising Crop Response in Tanzania: .....	24
III. Research Program Overview and Structure .....	25
Digital and Geospatial Tools Consortium – Building a new era of .....	25
Predictive Agricultural Innovation to Improve the Livelihoods of Smallholder Farmers .....	25
The Geospatial and Farming Systems Research Consortium (GFC) –.....	25
2015-2019.....	25
The Appropriate Scale Mechanization Consortium (ASMC 1 & 2) .....	25
Focus Country Research Subawards .....	26
IV. Theory of Change and Impact Pathway(s).....	27

	17
V. Research Project Reports.....	28
Theme I: Geospatial and Digital Tools for Farming Systems .....	28
I. Geospatial and Farming Systems Research Consortium (GFC) – (FY2015 – FY2020) .....	28
II. Digital and Geospatial Tools Consortium (FY2020 – FY 2023).....	29
Theme II: Appropriate Scale Mechanization for Smallholder Farmers .....	30
III. Summary of ASMC I Activities.....	30
IV. ASMC I - Bangladesh .....	31
V. ASMC I – Burkina Faso.....	33
VI. ASMC I - Cambodia.....	34
VII. ASMC I - Ethiopia.....	35
Theme III: Rice Fallows Systems and Horticultural Systems – South Asia .....	38
VIII. Bangladesh.....	38
IX. Cambodia – WAgN (FY2016 – FY2020).....	40
X. Cambodia – Scaling Suitable Sustainable (S3) Technologies (FY 2020 – FY 2023) .....	42
Theme IV: Crop-Livestock Interactions – West Africa .....	43
XI. Senegal .....	43
Theme V: Cereal and Legume Systems and Conservation Agriculture – East Africa.....	45
XII. Tanzania .....	45
VI. Associate Award Research Project Reports .....	47
A. Feed the Future Policy Impact Study (Policy Research Consortium).....	47
Award # S19050/A00-1012-S001- Kansas State University.....	47
VII. Human and Institutional Capacity Development.....	52
Short-term training.....	52
Long-term training.....	55
Institutional Development .....	59
VIII. Innovation Transfer and Scaling Partnerships .....	60
Plan of Action .....	60
IX. Environmental Management and Mitigation Plan (EMMP).....	61
X. Open Data Management Plan.....	62
XI. Governance and Management Entity Information.....	63
Regional and Country Coordinator Activity.....	63
SIIL Personnel Changes .....	63
Funding Extension Activities .....	64
No-Cost Extension Activities.....	64
SOILS Consortium Activities.....	64
iREACH Agreement Finalization and Implementation.....	64
XII. Other Topics.....	65



	18
Center of Excellence on Sustainable Agricultural Intensification and.....	65
Nutrition (CE SAIN) at the Royal University of Agriculture.....	65
Gender Integration Highlights: .....	68
Nutrition Integration Highlights:.....	68
XIII. Issues.....	69
COVID-19.....	69
XIV. Future Directions and Activities .....	70
Implementing Extended Projects and Consortia .....	70
Evaluating System Productivity, Synergies and Tradeoffs.....	70
Mobile Application and Video for the SI Assessment Framework.....	70
Appendices.....	71
Appendix A    List of Awards Given to U.S. Universities.....	75
Appendix B    Success Stories.....	77

## I. Executive Summary

The Feed the Future Innovation Lab for Collaborative Research on Sustainable Intensification (SIIL) successfully completed its sixth year since inception. All awards completed five years of active research and data collection in SIIL's focus countries (Bangladesh, Burkina Faso, Cambodia, Ethiopia, Malawi, Senegal, and Tanzania). SIIL continues to support the goal of developing an integrated research portfolio of sustainable intensification practices that offer the greatest potential to reduce hunger while improving the resilience and nutrition status of smallholder farmers in the target regions. This fiscal year SIIL has positioned itself to build on the achievements of the past five years while ensuring the continued relevance of the research with a renewed focus on leveraging regional efforts, strengthening local institutional and human capacity with the goal of working towards the *journey for self-reliance*.

During this past year, prior research projects and consortia were finalizing their activities and preparing for the next phase. This report highlights the final activities, accomplishments and lessons learned from the first phase along with the extended projects and consortia planned for upcoming years. Project teams identified promising innovations from their research using a systems approach, actively collaborating with our strategic partners to leverage investments, and communicating our successes through our multiple knowledge management platforms that will ensure greater impact and return on investments. The SIIL continues to grow by collaborating with more than 100 national and international organizations (including 8 CGIAR and 18 US universities), and supporting more than 120 scientists and 128 students to work towards increasing sustainable agriculture productivity, enhancing resilience of cropping systems, and supporting nutritional outcomes.

Through a rigorous review process, SIIL extended the following projects for a period of three years: Appropriate Scale Mechanization Consortium (ASMC 2), the polders research in coastal Bangladesh, the agro-pastoral farming systems in Senegal, the scaling sustainable technologies in Cambodia, and a new digital and geospatial tools consortium. These awards began limited implementation late in fourth quarter (Q4) of the year and will be fully operational in FY 2021. Highlights from finished projects include: ASMC I hosted trainings focused on private sector enterprises to improve service business related agricultural mechanization techniques, collaborating with many in-country partners, organizations, and educational institutions to help build capacity. The ASMC Ethiopia Hub found that maize crops cultivated after irrigated and fertilized vegetables or fodder increased maize yield substantially as compared to baseline conditions due soil fertility improvement from residual nutrients from dry season cropping. The Bangladesh Polder project focused on introducing smallholder farmers to improved cropping techniques for rainy-season and post-rainy season crops that can increase productivity and livelihoods in the Polder communities. The Cambodia WAgN project continued to empower women and improve nutrition by creating and extending new and improved methods for home gardening using indigenous plants, farming with a view towards conservation agriculture, using “green manure” composting techniques, and supporting women in completing their degrees in higher education. The Senegal team promoted ways to increase both the food security and nutritional status, as well as the incomes of women and children in their focus regions by using dual-purpose millet to create highly nutritious porridge for human consumption, and fodder for animals. Lastly, the Tanzania team worked to complete several publications based on the research conducted over the last 5 years.

Other highlights include: a) completion of the first phase projects through their no-cost extensions, b) finalization of the contracts for extended projects, c) extension of the Policy Research Consortium, d) development of a training video and mobile application for Sustainable Intensification Assessment Framework (SIAF) Tool Kit, and, e) finalization of the collaboration between USAID, SIIL and CORAF for the iREACH initiative in West Africa.

SIIL is committed to human and institutional capacity building as evidenced by the number of short-term trainings offered to 2,139 individuals (628 women, 29%), while lower than usual due to COVID-19 limitations, this still represents a significant amount of capacity building achieved under the circumstances. During FY 2020, SIIL supported 75 individuals (33 females, 45%) in long-term degree programs. Of the 75 individuals, 29 are pursuing a Ph.D. degree (38% females), 31 Masters of Science (58% females), and 15 are pursuing undergraduate degrees (33% females). SIIL country coordinators continued to provide support to partners on the implementation and coordination of research, capacity building activities, communication and support of ongoing research.

## II. Focus Country Key Accomplishments Bangladesh

In Bangladesh, SIIL funded projects conducted by the Appropriate Scale Mechanization Consortium (ASMC) I through their no-cost extension ending September 2020. As a part of the funding extension, ASMC 2, slated to begin work in October 2020, will continue to concentrate on the improved mechanization innovations and techniques created during their first phase for scaling. Additionally, the project, “Unlocking the production potential of polder communities in coastal Bangladesh” completed its work in polders dealing with improved rice planting techniques, and improved production and cultivation practices in March 2020, and has been working to set up operations for its next iteration focused on the “Pathways of scaling agricultural innovations for sustainable intensification in the polders of coastal Bangladesh”. Below are highlights from the projects that worked in Bangladesh during FY 2020, including the no-cost extension period:

### I. ASMC 1:

1. Forty-one women participated in field days in Wazirpur, Barishal and Dumuria, Khulna on the rice seedling raising process, tray/mat preparation, and operations like irrigation and pest management.
2. Multiple field days, demonstrations, and training programs were conducted for operators, mechanics, local engineering workshop owners, and farmers on harvesting machines seedling raising, and rice transplanter operations (see short-term trainings for complete list).
3. Developed and finalized training manual for both reaper and mini-combine harvester in English and Bengali, which will be printed as a booklet for distribution among the stakeholders at field-level. Two leaflets for both reaper and mini-combine harvester have already been printed.
4. Three farmers each from ten different sites around Bangladesh participated in field days and were trained in operating, maintaining and troubleshooting conservation agriculture and irrigation machinery. Research findings were presented in various international and national conferences and workshops.

### II. ASMC 2:

- I. Contract finalization and project implementation preparation.

### III. *Unlocking the Production Potential of Polder Communities in Coastal Bangladesh (2016-2020):*

1. The SIIL-Polder team organized trainings for five Learning Hubs in Polder 30 on fertilizer and pest management, with a focus on rodent management in rice. A total of 55 men and women farmers participated in the training program.
2. The team identified four polders adjacent to Polder 30, where the findings of the SIIL-Polder Project has the potential to be scaled-up for improving food security and income of the climate-vulnerable rural community.
3. The project provided training to 91 women farmers and women leaders in the southwest region on fertilizer and pest management in high yielding variety (HYV) of rice, rabi crops cultivation on moist soil and management practices for higher yield and income, and importance of zinc-enriched rice, maize, mungbean and sunflower on household nutrition, especially on children and lactating women.
4. Empowerment of 17 male youth on cost-effective fertilizer and weed management in dry season cropping by using mini-tillers and encouraged them to develop as agri-entrepreneurs.

### IV. *Pathways of Scaling Agricultural Innovations for Sustainable Intensification in the Polders of Coastal Bangladesh*

- I. Contract finalization and project implementation preparation.

## Burkina Faso

The Appropriate Scale Mechanization Consortium (ASMC 1) was also active in Burkina Faso through their no-cost extension ending in September 2020. As a part of the funding extension, ASMC 2, slated to begin work in October 2020, will continue to concentrate on scaling up the improved mechanization innovations and techniques created during ASMC's first phase, including improved oxen yokes and soil tillers. Below are the highlighted activities completed in Burkina Faso during FY 2020, including the no-cost extension:

### V. ASMC 1:

1. Several technical documents and manuals have been created for ASMC innovations, including: the ASMC improved planter, the semi-automated solar panel drip irrigation system, and the improved plastic PVC joug for oxen.
2. Additionally, there were technical manuals created from the following improved techniques: reduction of forage and crop residue size with the ASMC improved chopper, silage making using recycled plastic cans, and conservation agriculture using the ASMC improved ripper for minimum soil preparation.
3. ASMC phase II activities are well planned and now the local team is working on the GAP analysis which will start at the beginning of October 2020.

## Cambodia

The Women in Agriculture Network (WAgN) continued their work with women's farming groups and the University of Battambang (UBB) to create improved farming, gardening and planting practices in Cambodia. The S3 Cambodia: Scaling Suitable Sustainable Technologies will augment the research conducted by the WAgN project to improve the diffusion and adoption of the innovations created through the first project. ASMC will also continue their research implemented in their first phase. Below are the highlighted activities completed in Cambodia during FY 2020, including the no-cost extension:

### VI. ASMC 1:

1. Participated in 11th ICERD (International Conference on Environment and Rural Development) and 2nd SAIN (Sustainable Agricultural Intensification and Nutrition) conference and shared presentation on Time-motion study and task analysis of conservation agriculture vegetable production in Northwest Cambodia.
2. Completed E-learning materials on "No-till planter".
3. Finalized and submitted the 5 years strategic plan and program plan of FABE (Faculty of Agricultural and Biosystems Engineering) to Royal University of Agriculture (RUA).
4. Finalized a handbook for extension experts on "Not new, but modern conservation agriculture for commercial vegetable home gardens and supporting hand tools".

### VII. ASMC 2:

1. Contract finalization and project implementation preparation.

### VIII. Women in Agriculture Network (WAgN) (2016-2020):

1. Submitted three manuscripts to peer-reviewed journals.
2. Ms. Sovannary Huot completed her PhD program at Penn State University, which focused on gender roles within Cambodian agricultural cooperatives.
3. Awarded \$175k grant to develop UBB capacity through the World Bank Higher Education Improvement Project as a direct result of the WAgN project.
4. Developed a nursery network focused on wild food plant propagation and distribution. One Battambang nursery is producing over 500 Acacia pennate, which will become a key component of wild gardens in the S3 Green Labs.

5. The WAgN team developed a successful proposal for the second phase of SILL titled S3-Cambodia: Scaling Suitable Sustainable Technologies. This proposed project features a prominent youth engagement component, focused on CE SAIN-partner high schools and vocational agriculture high schools across Cambodia.

### **IX. S3 Cambodia – Scaling Suitable Sustainable Technologies:**

1. Contract finalization and project implementation preparation.
2. Recruited MS student in Agricultural Leadership, Education and Communications (ALEC) at the University of Tennessee. Gracie Pekarciak will support curriculum development for green labs and scaling research for S3-Cambodia.
3. S3 is working with the Ministry of Education, Youth and Sport on how to engage schools and create curriculum as a part of their pathways to scaling. They attended a conference where high school principals from all over Cambodia participated, and former SILL-supported graduate student and current UBB technician was able to present S3's vision to the principals.

## **Ethiopia**

The ASMC completed its work in Ethiopia in FY 2020, which included the no-cost extension through September 2020 which concludes their work in this country. Below are the highlighted activities completed in during that time period, including the no-cost extension:

### **X. ASMC I:**

1. End-line survey: A survey of 225 rural households covering 12 kebeles of the three ASMC intervention districts is completed aiming to evaluate the impact of the ASMC-Bahirdar Institute of Technology (BiT) project interventions (supply of various appropriate scale mechanization technologies) on smallholder farmers, considering the following outcome variables (such as household food security, net income earning, labor and land productivity in farm production, reducing the drudgery and workload of women, etc.) that need to be measured as indicators of the effect of interventions.
2. Analysis and evaluation of current proven agricultural mechanization technologies: Different technologies have been adopted to fit the identified demand of smallholder farmers in the selected districts and capacity building activities on engineering design, fabrication, and implementation of technologies have been accomplished during the no-cost extension period. Among others are the development of new animal fodder processing machines, adoption of ram pump, the adoption of the solar collapsible dryer and open sun drying methods, and the implementation of various grain storage technologies.
3. Introduce, improve, and mechanize conservation agriculture vegetable production: In this part of the research evaluation of small-scale irrigation technologies (Maji pump, drip and overhead water application systems) and conservation agriculture practices has been conducted against sustainability pillars (productivity, economic and environment). Conservation agriculture practice here refers to minimum soil disturbance through no-till practice, application of organic mulch cover, and diverse cropping in time. Paired-'t' design was used to evaluate various paired management practices in the study site. The result showed that conservation agriculture practices has a significant improvement on crop agronomy, yield and water productivity of various vegetables.
4. Assessment of existing water lifting technology and provide an alternative technology making use of renewable energy which is user-friendly, easily maintainable and cost-effective was also another activity. The aim of this activity was is to minimize the burden of woman and children on fetching and collecting water by developing and manufacturing water rising mechanisms (ram pump), which is a gravity-powered device that can raise water from valleys 24/7 for the people living in rural areas with no external power input.



## Senegal

The “Adoption of Sustainable Intensification in Dual-Purpose Millet-Leguminous Crops-Livestock Systems to Improve Food and Nutritional Security and Natural Resources Management for Rural Small Holder Farmers in Senegal” project completed its first 5 years, focusing on developing varieties of dual-purpose millet for human and animal consumption, providing ways to increase livelihoods among smallholder farmers and increase nutrition security among women and children. The extended Senegal project is focused on “Improving food and nutrition security of smallholder agro-pastoral farming systems by integrating crop-livestock-human nutrition in Senegal and Niger”, and will build upon the previous research completed with the first project. This project will also expand its focus to encompass a more regional approach in West Africa. Below are the highlighted activities completed in Senegal during FY 2020, including the no-cost extension:

### **XI. Adoption of Sustainable Intensification in Dual-Purpose Millet-Leguminous Crops-Livestock Systems to Improve Food and Nutritional Security and Natural Resources Management for Rural Small Holder Farmers in Senegal (2016-2020):**

1. Field days in Bambey and Passy were organized by Agence National de Conseil Agricole et Rural (ANCAR) and a workshop to share the dual-purpose millet trials was organized by farmer organization RESOPP (Reseau des Organisations Paysannes et Pastorales du Senegal) in Thies for local and lead farmers, co-PIs, RESOPP technicians (farmers' Co-Op), researchers, extension agents, and processors to provide capacity-building opportunities in the region.
2. As part of the development of millet for the manufacture of poultry feed, six (6) chicken coops were installed in the community of Malicounda. By using pearl millet seed by-products (hulls), women in the community were able to grow chickens, enabling them to generate extra income and provide animal-based protein to their families.
3. The biochemical analysis of the five varieties of millet carried out shows first that the introduced varieties (SL423 and SL169 particularly) are generally richer in carbohydrates, proteins and minerals than the references (Souna3 and Tchalack). It was noted that among the varieties introduced, SL423 and SL169 would be more suitable for making infant flours because their micronutrients, proteins and carbohydrate contents. Thus, SL423 would be more suitable against micronutrient (iron and zinc particularly) malnutrition, while SL169 would be more able to fight against protein-energy malnutrition.

### **XII. Improving Food and Nutrition Security of Smallholder Agro-Pastoral Farming Systems by Integrating Crop-Livestock-Human Nutrition in Senegal and Niger:**

1. Contract finalization and project implementation preparation.
2. The women’s organization, KEUR GUI, in Malicounda, produced over 200 kg of enriched flour with an average price of 1,000F CFA (US \$2.0) per kg and 400 kg of Thiackry with a price of 1,000 CFA (US \$2.0) per bag of 800 g.
3. Creation and implementation of seed production plots for dual-purpose millet varieties of Thialack2, SL28, SL169, and SL423 to compare them to Souna 3 at Nioro and Bambey research stations.
4. On station feeding trial refining, including: implementation of experiments on rationing for the fattening of young bulls and millet production at ENSA (Ecole Nationale Superieure d’Agriculture), Implementation of millet farm for dual-purpose stover production, and the acquisition of concentrated animal feed and veterinary products for the coming feeding trial experiment.

## Tanzania

The “Raising crop response: bidirectional learning to catalyze sustainable intensification at multiple scales” project in Tanzania has completed their in-country work as a part of SIIIL. Below are the highlighted activities completed by the project during FY 2020, including their no-cost extension through June 2020:

### ***XIII. Raising Crop Response in Tanzania:***

1. A new policy on maize price regulation was developed and disseminated to over 150 policy makers, donors, advocacy groups and farmers unions.
2. Innovations in client-oriented extension include utilization of the LandPKS smartphone application to reach farmers with extension recommendations in the Southern Highlands, documented in a Land Development and Degradation published journal article.
3. A manuscript was submitted that documented the current status of the research and how to improve child feeding practices, based on a household survey and sampled food portions analyzed for aflatoxin: 'Monotonous Cereal Based Complementary Feeding Contributes to Aflatoxin Exposure in Children'.

### III. Research Program Overview and Structure

#### Digital and Geospatial Tools Consortium – Building a new era of Predictive Agricultural Innovation to Improve the Livelihoods of Smallholder Farmers

The new and restructured Geospatial Farming Systems Consortium will focus on providing high-resolution soil, climate, crop, livestock, nutrition, and socioeconomic data. These datasets can help in quantifying past conditions and inform future changes in the adoption of different management practices to improve the overall resiliency and sustainability of agricultural systems in the targeted regions (e.g., West Africa and Asia) and in the Feed the Future Zones. The consortium plans to focus on creating and promoting the following based on their proposed objectives:

- *Modeling tools*: to examine mixed crop-livestock farming systems' suitability and land capability for agriculture productions in targeted regions.
- *Remote-sensing products*: to assess current conditions, trends, and potential future conditions in targeted countries.
- *Connection*: to link agricultural productive capacity and child malnutrition using livestock ownership, field size, use of improved seeds and fertilizer, and climate variability.
- *Resilience*: to examine the potential implications of agricultural innovations on social and biophysical risk and resilience at local test sites in targeted regions.
- *Innovation integration*: develop geospatial products that integrate across project outputs to map biophysical and social risk analysis for the targeted regions and the potential of specific agricultural innovations to increase resilience in the face of climate change.

#### The Geospatial and Farming Systems Research Consortium (GFC) – 2015-2019

The GFC brings together leading geospatial researchers to enhance the efficiency and success of agricultural research and development. The GFC works closely with the research subaward team to enhance their capacity. Specific activities and outcomes of the members is listed separately in the next section. GFC research encompasses five thematic objectives:

- *Land*: To identify current patterns of intensification and opportunities for sustainable intensification.
- *Inputs*: To improve the resource use efficiency in crop production.
- *Management*: To design crop growth monitoring tools.
- *Productivity*: To estimate current and potential yield in the regions of interest.
- *Access*: To understand the impact of market socio-economic and environmental conditions on opportunities for intensification.

#### The Appropriate Scale Mechanization Consortium (ASMC I & 2)

The ASMC aims to introduce multifunctional and modular mechanized technologies that are technically, environmentally, economically and socially appropriate for use by smallholder farmers (including women) with the flexibility to accommodate different power sources. They are currently active in four countries. The specific intervention and entry point will vary by country as determined by the host country partners and needs of the producers. These technologies contribute to enhanced labor productivity and increased land productivity, thus sustainably reducing poverty among smallholders. The ASMC I had six key functions they were engaged in:

- *Engage* entry-point organizations to establish Innovation Hubs.
- *Assess* country-specific mechanization challenges, opportunities and priorities.
- *Implement* country-specific activities utilizing participatory research methods.
- *Train* and build human capacity with an emphasis on gender.

- *Monitor* and evaluate the impact of activities.
- *Share* knowledge with in-country stakeholders.

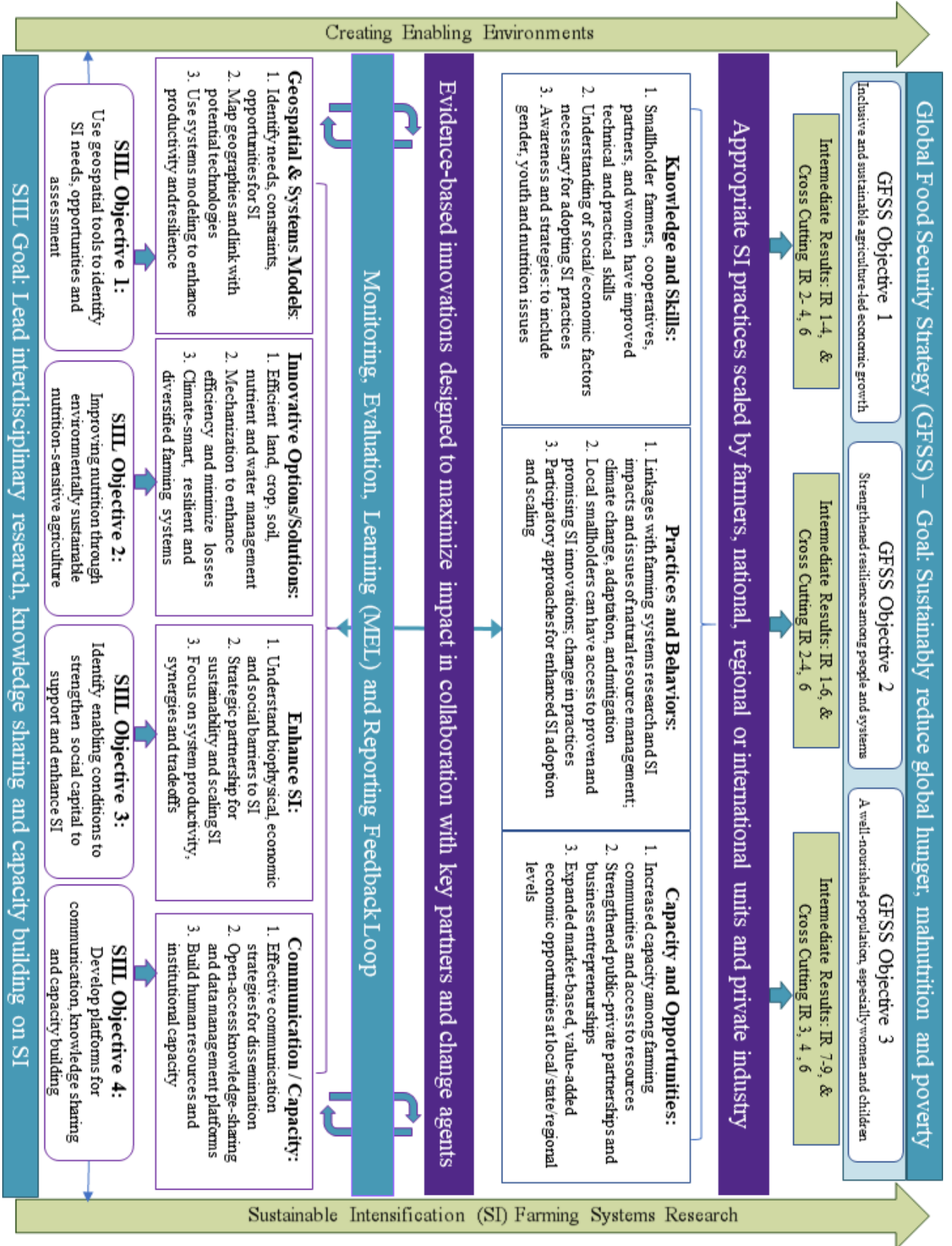
During the funding extension, ASMC 2 will build on the activities from ASMC 1 and work on scaling its innovations in 3 countries – Bangladesh, Burkina Faso, and Cambodia. The objectives for the next funding phase focus on the following objectives:

- *Scaling*: will work to scale SI innovations and associated technologies to stakeholders (farmers, manufacturers/ blacksmiths, extension, service providers, mechanics, private and public sectors).
- *Capacity Building*: will work to build technical and entrepreneurship capacity of service providers, fabricators and manufacturers, and mechanization experts in the focus countries.
- *Policy*: will work to create and contribute to an enabling policy environment for mechanization among smallholder farmers.

## Focus Country Research Subawards

The SILL supported four of the six country subawards (Bangladesh, Cambodia, Senegal and Tanzania) through the end of their no-cost extensions in FY 2020. The research projects focused on Burkina Faso, Ethiopia, and Malawi were completed in FY 2019. The SILL has also completed contracts with three country subawards in Bangladesh, Cambodia and Senegal, which will continue adopt a regional approach and will continue to be part of the SILL portfolio through the funding extension. Together, the research project subawards will investigate a diverse range of sustainable intensification practices and innovations across the SILL focus countries. The broad focus areas being crop-livestock interaction; better management of crops and livestock to enhance resource use efficiency; diversification (integration of legumes; home gardens; and new crops); and precision and sustainable agricultural practices. The SILL research subawards are implemented and led by collaborations between U.S. universities, NARES (National Agricultural Research and Extension Service) centers, NGOs, (Non-Government Organizations) and CGIAR (Consultative Group on International Agricultural Research) partners.

## IV. Theory of Change and Impact Pathway(s)





## V. Research Project Reports

### Theme I: Geospatial and Digital Tools for Farming Systems

#### I. Geospatial and Farming Systems Research Consortium (GFC) – (FY2015 – FY2020)

1. **Name:** Geospatial and Farming Systems Research Consortium (GFC, Principal Investigator (PI): Robert Hijmans, University of California, Davis)
2. **Locations:** Global – Due to the nature of the consortium’s research and the incorporation of remote sensing, the projects are often not location-dependent. The locations listed for each subaward report may refer to field work locations, targeted areas for remote sensing work, or a combination of the two. However, the processes and methods can be scaled globally.
3. **Description and Achievements (See FY 2020 AWP Objective 2):** The GFC focuses efforts, through a portfolio of research subawards and independent research, on five primary objectives. The achievements listed under each objective refer specifically to the efforts of the GFC leadership team at the University of California, Davis. This project focused on reporting and funding close outs and is now closed out.
  - Data analysis in two target countries – Senegal and Cambodia – was completed during their three-month no-cost extension, and twenty-four total data sets from their research were uploaded into the SIIL Dataverse.
  - Between 2014 and 2019, the GFC designed and launched more than 25 collaborative projects, the majority of which have been completed, including an open-access satellite database of cropland locations (<https://geosurvey.qed.ai/about/>), high spatial resolution information on crop growing areas in Tanzania, Bangladesh and Cambodia, and the global WorldClim platform (<http://worldclim.org/version2>).
  - Installation and training were completed on 11 total weather stations in Senegal (6) and Cambodia (5), which will be used to collect weather data for modeling purposes.
  - UAV training was conducted in Cambodia and Senegal for remote-sensing data collection, and websites were created to aid with UAV flight planning (<https://gfc.ucdavis.edu/guides/flightops/index.html>) and to collect post-flight data ([https://gfc.ucdavis.edu/guides/qgis\\_lab.html](https://gfc.ucdavis.edu/guides/qgis_lab.html)).
  - Eight publications and presentations on the consortium’s research activities were produced during the reporting period.
  - This consortium will be completed March 2020 and is in the process of being closed out. Full results from the consortium will be highlighted in the SIIL Five-Year Report available in June 2020.
4. **Capacity Building:**
  - None to report for FY 2020.
5. **Lessons Learned:**
  - None to report for FY 2020.
6. **Peer Reviewed Publications:**
  - Smith, JC, Ghosh A, Hijmans R. (2019) Agricultural intensification was associated with crop diversification in India (1947-2014). PLoS ONE 14: e022555.
  - Stirling CM, CR Farnworth, J Hammond, A Chinyopfir M. (2020) Household Methodologies to Reduce Gender Inequality and Increase Household Resilience to Climate and Other Shocks: A Case Study from Malawi. Climate Change (In Review)
  - Fraval S, Hammond J, Wichern J, Oosting SJ, de Boe. (2020) Making the most of imperfect data: a critical evaluation of standard information collected in cross-sectional farm household surveys. Experimental Agriculture (In Review)

- Hammond, J., et al. (Under Review). Next-generation household surveys to increase uptake, impact and return on investment for a nationwide NGO-led rural development program in Rwanda. *Agricultural Systems*
- Hammond, J., et al. (2019). Rapid pace of change for rural smallholders in East Africa: prosperity is driven by off farm income, in tandem with agricultural intensification. *Proceedings of the National Academy of Sciences of the United States of America*. - presentation
- Fraval et al. (2020). Nutritional gaps of rural households in east and west Africa: prevalence and determinants based on rapid indicators. *Global Food Security*.
- Fraval S, J Hammond, A Ayantunde, V Yameogo, S Oos. (2020) Pathways to food security in rural Burkina Faso: importance of consumption of agricultural produce versus food purchases. *Food Security*.
- Azzari, G., et al. (Under Review) Smallholder maize area and yield mapping at national scales with Google Earth Engine. *Remote Sensing of Environment*.

## II. Digital and Geospatial Tools Consortium (FY2020 – FY 2023)

1. **Name:** Digital and Geospatial Tools Consortium (DGTC, Principal Investigator (PI): Ignacio Ciampitti, Kansas State University)
2. **Locations:** *Global* – Due to the nature of the consortium’s research and the incorporation of remote sensing, the projects are often not location-dependent. The locations listed for each subaward report may refer to field work locations, targeted areas for remote sensing work, or a combination of the two. However, the processes and methods can be scaled globally.
3. **Collaborators:**
4. **Description and Achievements:** The DGTC will focus its efforts, through a portfolio of research subawards and independent research, on five primary objectives. The achievements listed under each objective refer specifically to the efforts of the DGTC leadership team at Kansas State University. Their subawards will be listed separately. While the contracts were completed in FY 2020, the DGTC will be working in FY 2021.
  - **Modeling tools:** to examine mixed crop-livestock farming systems' suitability and land capability for agriculture productions in targeted regions.
  - **Remote-sensing products:** to assess current conditions, trends, and potential future conditions in targeted countries.
  - **Connection:** to link agricultural productive capacity and child malnutrition using livestock ownership, field size, use of improved seeds and fertilizer, and climate variability.
  - **Resilience:** to examine the potential implications of agricultural innovations on social and biophysical risk and resilience at local test sites in targeted regions.
  - **Innovation integration:** develop geospatial products that integrate across project outputs to map biophysical and social risk analysis for the targeted regions and the potential of specific agricultural innovations to increase resilience in the face of climate change.
5. **Capacity Building:**
  - None to report for FY 2020.
6. **Lessons Learned:**
  - None to report in FY 2020.
7. **Peer Reviewed Publications:**
  - None to report for FY 2020.

## Theme II: Appropriate Scale Mechanization for Smallholder Farmers

### III. Summary of ASMC I Activities

1. **Name:** Appropriate Scale Mechanization Consortium (PI: Alan Hansen, University of Illinois at Urbana-Champaign)
2. **Locations:** Bangladesh, Burkina Faso, Cambodia, and Ethiopia
3. **Description:** The ASMC facilitates the introduction of multifunctional and modular mechanized technologies that are technically, environmentally, economically and socially appropriate for use by smallholder farmers. The overall objective of the project is to sustainably intensify smallholder farmers' cropping systems and on-farm operations through mechanization. The ASMC utilizes a user-centric systems approach through an Innovation Hub model in each of their four focus countries. The Hubs identify specific mechanization needs, leverage ASMC resources accordingly, and implement innovative solutions.
4. **Collaborators:** *United States* - Kansas State University, Michigan State University, and North Carolina A&T State University, ADM Institute for the Prevention of Postharvest Loss (Illinois). Additional international collaborators are listed under each ASMC country report.
5. **Achievements (See FY 2020 Annual Work Plan Objective 3):**
  - Focus country achievements are reported separately to capture the range of activities.
  - ASMIH Bangladesh team, with the help of trained operators, has been providing harvesting services to the farmers of interventions areas of Khulna, Barishal and Patuakhali districts with existing machines of the hub during *Boro* season (April to May 2020) by ensuring safety guideline. In Kalapara, Patuakhali, ASMIH-Bangladesh trained entrepreneur Mr. Jalil prepared 400 trays of paddy seedlings for *Aus* 2020 season. ASMIH-Bangladesh is monitoring harvesting and transplanting activities in the project areas over cell phone and video communication.
  - In Cambodia, the number of interns increased from a few to more than 10 per year. In addition, Cambodia is piloting a dual education program option, as COVID-19 epidemic broke the classroom teaching tradition, through the support from RUA and Faculty of Agricultural Biosystems Engineering (FABE) steering committees, ASMC Hub, and Swisscontact.
  - In Burkina Faso, an advisory committee meeting was held on the 13, 14 and 15th of November 2019 at Nazi Boni University. The last four years of the ASMC project were evaluated by the committee with the participation of project stakeholders (farmers, students, researchers, technicians and institutions). In total, 72 participants attended to different meetings with 7 females and 65 males (14 attended to advisory committee meeting, 49 to project evaluation meeting and 9 as writing committee of master program on Agriculture Mechanization). The three main innovations were: planting system, animal feeding system tools and drip irrigation system. With the planter, women liked planting and could have time to do other works on farm.
6. **Capacity Building:**
  - Met with cooperators in Senegal to establish a regional hub for scaling up of ASMC activities.
7. **Lessons Learned:**
  - This year presented many difficulties due to COVID-19, including travel plans and workshops postponed or canceled. Virtual platforms were required to continue communication with partners. Innovation Hubs were required to adapt plans.
  - It is important to introduce conservation agriculture (CA) in Burkina Faso. As such our planter is being used in conventional tillage system. This is something we must revisit.
  - ASMC has generated significant interest in our interventions. We must focus on scaling of our technologies going forward.
8. **Presentations and Publications:**
  - None to report at this time.

#### IV. ASMC I - Bangladesh

1. **Name:** Appropriate Scale Mechanization Innovation Hub (ASMIH) – Bangladesh
2. **Locations:** Innovation Hub location: Bangladesh Agricultural University, Mymensingh (Bangladesh)  
Field locations: Dumuria and Wazirpur (Bangladesh)
3. **Description:** The goal of the ASMIH - Bangladesh project is promoting appropriate-scale agricultural mechanization for sustainable intensification focusing on smallholder farming systems in Southern Delta region of Bangladesh. The target equipment interventions include: Rice transplanters; rice reapers, mini-combine rice harvesters, strip-tillage planters, no-tillage planters, bed planters, and axial flow pumps.
4. **Collaborators:** Bangladesh - Bangladesh Agricultural University (BAU), Bangladesh Rice Research Institute (BRR), Bangladesh Agricultural Research Institute, and ACI Motors Ltd.
5. **Achievements (See FY 2019 AWP Objective 3):**
  - Kubota NSP-4W model rice transplanter performance was evaluated in Subarnachar Noakhali and Wazirpur, Barishal in Boro-2019 season. The average effective field capacity, fuel consumption and field efficiency of the transplanter were found 0.18 ha/hr, 4.34 lit/ha, 69.04%, respectively.
  - Leaflet of rice transplanter was printed, which included the brief description on seedling raising, transplanter benefits, operation and troubleshooting, business scope. Training module has been developed to conduct training. The training manual consists of seedling raising techniques, transplanter technical parameter, and maintenance of the transplanter and general troubleshooting of the transplanter during operation in detail.
  - Experiments were conducted for hybrid variety rice at the BAU farm, Dumurlya and Khulna for estimating seed rate and evaluating performance of rice transplanter in both puddled and unpuddled soil conditions.
6. **Capacity Building:**
  - Forty-one women participated in field days in Wazirpur, Barishal and Dumuria, Khulna on the seedling raising process, tray/mat preparation, and operations like irrigation and pest management.
  - Multiple field days, demonstrations, and training programs were conducted for operators, mechanics, local engineering workshop owners, and farmers on harvesting machines seedling raising, and rice transplanter operations (see short-term trainings for complete list).
  - Developed and finalized training manual for both reaper and mini-combine harvester in English and Bengali, which will be printed as a booklet for distribution among the stakeholders at field-level. Two leaflets for both reaper and mini-combine harvester have already been printed.
  - Three farmers each from ten different sites around Bangladesh participated in field days and were trained in operating, maintaining and troubleshooting CA and irrigation machinery.
  - Research findings were presented in various international and national conferences and workshops.
7. **Lessons Learned:**
  - Availability of good mechanics and spare parts in the locality is a challenge.
  - Developing entrepreneurship for seedling nursery and transplanter custom hire business is difficult as the machine use is seasonal.
  - In some intervention areas, drainage is a problem during heavy rain. Therefore, suitable lands for transplanting in the areas are limited.
  - Student idea competition is a good practice for engaging academia and creating innovative ideas in agricultural mechanization.

## 8. **Presentations and Publications:**

- Mottalib A, Hossain MA, Hossain MI, Amin MN, Alam MM, Saha C. (2019). Assessment of cost-benefit parameters of conservation agricultural machinery for custom hires entrepreneurship in the southern region of Bangladesh (pp.94-103), <https://cigrjournal.org/index.php/Ejournal/issue/view/83>
- Sarkar S, Rabbani MA, Saha C, Alam MM. (2020). Assessment of custom hiring service provision for rice transplanter in the southern delta of Bangladesh using rural invest tool, 2020 ASABE Annual International Meeting - *presentation*
- Hasan MK, Ali MR, Saha C, Alam MM, Haque ME. (2019). Combine harvester: impact on paddy production in Bangladesh (pp.583-591). Journal of Bangladesh Agricultural University, <https://doi.org/10.3329/jbau.v17i4.44629>
- Sarkar S, Basir MS, Rabbani MA, Hossain MM, Alam MM. (2020). Financial analysis for custom hire business of mechanical rice transplanter in Bangladesh (pp.124-130). Fundamental and Applied Agriculture. doi: 10.5455/faa.79466
- Hasan MK, Tanaka T, Alam MM, Ali R, Saha C. (2020). Impact of modern rice harvesting practices over traditional ones. Reviews in Agricultural Science (pp. 89-108). [https://dx.doi.org/10.7831/ras.8.0\\_89](https://dx.doi.org/10.7831/ras.8.0_89)
- Basir MS, Sarkar S, Rabbani MA, Saha C, Hossain MM, Alam MM. (2019). Mechanical transplanting of hybrid variety rice for sustainable food security. International Conference on Sustainable Agriculture-2019, October 19-20, 2019, Bangladesh Agricultural University, Mymensingh, Bangladesh. (Abstract)
- Sarkar S, Rabbani MA, Saha C, Hossain MM, Alam MM. (2019). Seedling raising nursery business for sustainable mechanical rice transplanting in the Southern delta of Bangladesh. International conference on sustainable agriculture - ICSA 2019. (Conference Paper)
- Pathan S, Ali R, Hasan MK, Saha C, Alam MM. (2020). Investigation of harvesting track and heading change of paddy harvester using geo-referenced data (pp.235-243). Agricultural Engineering International: CIGR Journal. <https://cigrjournal.org/index.php/Ejournal/article/view/5512>
- Sarkar S, Saha C, Rabbani MA, Hossain MM, Alam MM, Rahman MH. (2020). Scope of mechanical transplanting for sustainable rice production in the southern delta of Bangladesh. Sustainable Agriculture and Rural Development: Road to SGDs (Conference Paper)
- Hasan MK, Ali MR, Saha C, Alam MM, Rahman MS. (2020). Provision of custom hiring service of mini-combine harvester for paddy harvesting: an experimental evidence from Bangladesh. International Journal of Agriculture Innovation, Technology and Globalisation.
- Hasan MK, Ali MR, Saha C, Alam MM, Hossain MM. (2020). Technical performance and benefit of mini-combine harvester in southern delta of Bangladesh. Journal of Agricultural Mechanization in Asia, Africa & Latin America.
- Mottalib MA, Hossain MA, Amin MN, Saha C, Alam MM. (2020). Suitability analysis of conservation agriculture-based tillage cum planting technology using satellite remote sensing and GIS for adaption in southern region of Bangladesh. 2020 ASABE Annual International Meeting. <https://doi.org/10.13031/aim.202000784> (Conference Paper)
- Hasan MK, Ali MR, Saha C, Alam MM. (2020). Sustainable Paddy Harvesting Solution for the Southern Delta of Bangladesh. 2020 ASABE Annual International Meeting. <https://doi.org/10.13031/aim.202000785> (Conference Paper)



## V. ASMC I – Burkina Faso

1. **Name:** Appropriate Scale Mechanization Innovation Hub (ASMIH) – Burkina Faso
2. **Locations:** Innovation Hub location: Polytechnic University of Bobo-Dioulasso, Bobo-Dioulasso (Burkina Faso); Field locations: Koumbia, Burkina Faso
3. **Description:** The main objective of the project in Burkina Faso was to increase maize productivity through appropriate scale mechanization using animal draft for smallholder farmers. The targeted equipment interventions included: a refined ox yoke, single row ox-driven planter, conservation ripper (chisel plow), and an animal-drawn crop cultivator. Other tools include forage/fodder chopper and solar powered irrigation systems.
4. **Collaborators:** Burkina Faso - Polytechnic University of Bobo-Dioulasso; United States - Tillers International
5. **Achievements (See FY 2020 AWP Objective 3):**
  - Several technical documents and manuals have been created for ASMC innovations, including: the ASMC improved planter, the semi-automated solar panel drip irrigation system, and the improved plastic PVC joug for oxen.
  - Additionally, there were technical manuals created from the following improved techniques: reduction of forage and crop residue size with the ASMC improved chopper, silage making using recycled plastic cans, and conservation agriculture using the ASMC improved ripper for minimum soil preparation.
  - ASMC phase II activities are well planned and now the local team is working on the GAP analysis which will start at the beginning of October 2020.
6. **Capacity Building:**
  - Twenty-eight (28) students (Bachelor’s degree and Engineering/Master’s degree) were included in the project and now defended their respective thesis. Those learned a lot by collaborating with Tillers International, Michigan State University and other INERA and Nazi Boni University researchers, farmers and local blacksmiths. Now, they understand the project goals and are better able to help farmers and other enterprises increase their ability to improve their agriculture business.
  - Linda Stella Zugmore successfully defended her master’s degree thesis on 30th July 2020.
7. **Lessons Learned:**
  - There is increased interest in ASMC innovations and people better appreciated the Innovation Hub strategies and trainings.
  - Agricultural innovations should be carried out with farmers and local blacksmiths. It will increase adoption rate and ease of use for the end users.
  - The Innovation Hub concept through demonstration site gathers researchers, farmers, students and local blacksmiths together and improves collaboration among those different groups.
  - The ASMC project, by improving planting techniques and systems, has brought many solutions to farming communities around Burkina Faso. This was covered by several television stations (state and private TV, as well as the official newspaper), news reports and in comments on social media. The impact has been great and widespread.
  - Rural development students are very important for the implementation of projects in Burkina Faso. This approach will help guarantee project success.
8. **Presentations and Publications:**
  - Harrigan T, Jones M. (2020) "Now we can breathe.": the impact of a mechanical maize planter on smallholder women farmers in Burkina Faso. AgriLinks.

- Manzamasso H, Kere M, Millogo V, Srivastava A, Schwab B. (2020). Demand for agricultural mechanization in the Houts-Bassin Region (HBR) in Burkina Faso. *African Journal of Agricultural and Resource Economics*.
- Millogo V. (2020). Évaluation de la force et de la vitesse de travail des boeufs de trait à l'aide d'un dynamomètre numérique en début de campagne agricole au Burkina Faso (pp.2295-8010). *Tropicultura*.
- Sayaogo B, Millogo V, Dianda S, Kere M, Barro A, Burdick R, Harrigan T, Pousga S, Bougouma-Yameogo V, Joshi N, Srivastava A. (2020). Technical paper for the use of ASMC planter for planting maize using animal draft.
- Kere M. (2020). Household food consumption profile of maize farmers in rural areas: Burkina Faso's Hauts-Bassins Region Case (pp.667-687). *International Journal of Innovation and Applied Studies*.

## VI. ASMC I - Cambodia

1. **Name:** Appropriate Scale Mechanization Innovation Hub (ASMIH) – Cambodia
2. **Locations:** Innovation Hub location: Royal University of Agriculture, Phnom Penh (Cambodia)  
Field locations: Banan district (Battambang province), Puok district (Siem Reap province), and Stung Chinit (Kampong Thom province)
3. **Description:** The main objectives of the ASMIH-Cambodia include:
  - To design and assess conventional and direct seeding mulch-based cropping systems.
  - To assess the performance of appropriate scale machinery while preserving soil capital.
  - To adapt and train smallholder farmers, service operators, field technicians, and students on the use of ASM and conservation agriculture (CA)-based cropping systems.
  - To support multi-stakeholder initiatives.
  - To initiate a negotiation process between farmers for the individual or collective management of fodder sources or crop diversification after wet season rice.
4. **Collaborators:** Cambodia - Institute of Technology of Cambodia (ITC), Royal University of Agriculture (RUA), Conservation Agriculture Service Center (CASC), Ministry of Agriculture Forestry and Fisheries (MAFF), University of Battambang (UBB); France - CIRAD
5. **Achievements (See FY 2020 AWP Objective 3):**
  - Participated in 11<sup>th</sup> ICERD and 2<sup>nd</sup> SAIN conference and shared presentation on Time-motion study and task analysis of conservation agriculture vegetable production in Northwest Cambodia.
  - Completed E-learning materials on “No-till planter”.
  - Finalized and submitted the 5 years strategic plan and program plan of FABE to RUA’s committee.
  - Finalized a handbook for extension experts on “Not new, but modern conservation agriculture for commercial vegetable home gardens and supporting hand tools”.
6. **Capacity Building:**
  - Organized a training of trainers in the internship program in cooperation with Swisscontact to build the capacity of the faculty and staff on some courses and skills such as Business Management, Marketing Strategy, Soft Skills those required to provide to the selected interns before beginning their the internship at private companies.
  - Recruited 2 undergraduate students to conduct a 6-month internship at Larano Manufacturer and Importer for the 2nd cycle internship project in collaboration with MIGIP project of Swisscontact.
  - One student from UBB attended ICERD 11<sup>th</sup> international conference in Siem Reap province.
  - Organized field visit for students to 3 target areas in Battambang, Kampong Thom, and Siem Reap, including the Bos Knor research station in Kampong Cham province.

- Organized consultation meetings to improve the existing curricula.
7. **Lessons Learned:**
- Consultation meetings with faculty members, Prof. Dr. Ting Kuan Chong, and Prof. Dr. Manny Reyes to review and develop the existing curricula is important.
  - All classes and workshops were cancelled due to COVID-19, causing a delay of all study and research. Practical study in workshops was initially impossible to handle but were later able to proceed with a limited number of students per session. COVID-19 not only delayed the academic semester, but also the research being conducted for thesis of the students.
  - All meetings in large groups, on-farm demonstrations, and survey activities cannot be done, either.
  - Internships can continue, but instruction and trainings have been changed from traditional in-person to distance teaching methods, as a result of COVID-19.
8. **Presentations and Publications:**
- Rien S, Channaty N, Pao S. (2020). Time-motion study and task analysis of conservation agriculture vegetable production in Battambang, Cambodia. 11th International Conference on Environmental and Rural Development and the 2nd Conference on Sustainable Intensification and Nutrition, Siem Reap, Cambodia. - *presentation*
  - Pao S, Lor L, Chan S. (2020). Status and trends in agricultural mechanization in Cambodia. - *presentation*
  - Vernet PA, Faysse N, Suos V, Theng D, Oung N. (2019). Investing in a no-till planter in Cambodia: a promising opportunity for various types of service providers. International Journal of Agricultural Sustainability.

## VII. ASMC I - Ethiopia

1. **Name:** Appropriate Scale Mechanization Innovation Hub (ASMIH) – Ethiopia
2. **Locations:** Innovation Hub location: Bahir Dar Institute of Technology, Bahir Dar University (Ethiopia)  
Field locations: Bahir Dar Zuri, Bure Zuria, Dangila, (Ethiopia)
3. **Description:** The ASMIH – Ethiopia aims to develop and refine sustainable mechanization practices with draft animals and emphasis on zone tillage, seeding, weeding, and shelling technologies for maize that will be readily transferrable to other cropping systems. The scope of activities includes prototype testing and evaluation, train-the-trainer sessions for local extension and technical service providers, on-farm evaluation and artisan training for local manufacturing and marketing of technologies, tools and custom services.
4. **Collaborators:** Ethiopia - Bahir Dar University, Bahir Dar Institute of Technology; United States - Feed the Future Innovation Lab for Small Scale Irrigation, International Water Management Institute (IWMI), and International Livestock Research Institute (ILRI)
5. **Achievements (See FY 2020 AWP Objective 3):**
  - End-line survey: A survey of 225 rural households covering 12 kebeles of the three ASMC intervention districts is completed aiming to evaluate the impact of the ASMC-BiT project interventions (supply of various appropriate scale mechanization technologies) on smallholder farmers, considering the following outcome variables (such as household food security, net income earning, labor and land productivity in farm production, reducing the drudgery and workload of women, etc.) that need to be measured as indicators of the effect of interventions.

- Analysis and evaluation of current proven agricultural mechanization technologies: Different technologies have been adopted to fit the identified demand of smallholder farmers in the selected districts and capacity building activities on engineering design, fabrication, and implementation of technologies have been accomplished during the no-cost extension period. Among others are the development of new animal fodder processing machines, adoption of ram pump, the adoption of the solar collapsible dryer and open sun drying methods, and the implementation of various grain storage technologies.
- Introduce, improve, and mechanize conservation agriculture vegetable production: In this part of the research evaluation of small-scale irrigation technologies (Maji pump, drip and overhead water application systems) and Conservation agriculture practices has been conducted against sustainability pillars (productivity, economic and environment). Conservation agriculture (CA) practice here refers to minimum soil disturbance through no-till practice, application of organic mulch cover, and diverse cropping in time. Paired-'t' design was used to evaluate various paired management practices in the study site. The result showed that CA has a significant improvement on crop agronomy, yield and water productivity of various vegetables.
- Assessment of existing water lifting technology and provide an alternative technology making use of renewable energy which is user-friendly, easily maintainable and cost-effective was also another activity. The aim of this activity was to minimize the burden of woman and children on fetching and collecting water by developing and manufacturing water rising mechanisms (ram pump), which is a gravity-powered device that can raise water from valleys 24/7 for the people living in rural areas with no external power input.

#### 6. **Capacity Building:**

- During the no-cost extension period a total of 9 trainings were held in the area of technical skill development, machinery and equipment maintenance, bookkeeping, entrepreneurship development and small business planning, and conservation agriculture. These were given to different groups of individuals including farmers, small businesses, manufacturers, maintenance technicians, and agricultural agents.
- 2 Ph.D. students (one in mechanical engineering and the other on post-harvest technologies), 4 MSc students (in gender and development, post-harvest technologies, technology valuation, and financial modeling, and conservation agriculture) are engaged in research activities.

#### 7. **Lessons Learned:**

- Impact of COVID-19 on project activities.
- A major concern of the project is its continuity. The scalability and sustainability of the implemented technologies and the transferred knowledge will depend on the follow-up of these activities after the completion of the project life span.
- As a project team, we are designing different mechanisms to sustain the mechanization innovation hub in Bahir Dar Institute of Technology at Bahir Dar University.
- In pursuing the different activities, we have learned that appropriate mechanization technologies have helped farmers to improve their lives in terms of economic growth, gender equality, youth engagement and productivity improvement.

#### 8. **Presentations and Publications:**

- Asres S, Schmitter P, Reyes MR, Tilahun SA, Steenhuis T, Worqlul A. (2019). Conservation agriculture saves irrigation water in the dry monsoon phase in the Ethiopian highlands (pp.1-16). Water Journal, 11, Basel. doi:10.3390/w1
- Assefa T, Reyes MR, Tilahun SA, Worqlul A, Jha M. (2020). Conservation agriculture with drip irrigation: Effects on soil quality and crop yield in sub-Saharan Africa (pp.209-217). Journal of Soil and Water Conservation.

- Gebeyehu SG, Dedimas T. (2020). Developing appropriate business model for maize shelling technologies in small holder farmers in north west Ethiopian districts. *Journal of Engineering and Technology Management*.
- Yimam AY, Assefa T, Tilahun SA, Jha M, Reyes MR. (2020). Experimental evaluation for the impacts of conservation agriculture with drip irrigation on crop coefficient and soil properties in the sub-humid Ethiopian highlands (pp.1-20). *Water Journal*. doi:10.3390/w12040947
- Assefa T, Jha M, Worqlul A, Reyes MR, Tilahun SA. (2020). Scaling up field-level crop production with small-scale irrigation and conservation practice by integrating the MCE technique and the APEX model. *Water Journal*.



## Theme III: Rice Fallows Systems and Horticultural Systems – South Asia

### VIII. Bangladesh

1. **Name:** Unlocking the production potential of “polder communities” in coastal Bangladesh (PI: Krishna Jagadish, Kansas State University; and Sudhir Yadav, IRRI)
2. **Locations:** Polder 30 in the Khulna district of Bangladesh
3. **Description:** The primary objective of the project is to increase farm income and nutrition security by intensifying polder farming systems through implementation of sustainable and economically viable practices. Specifically, the project aims to advocate for high yielding and stress tolerant rice varieties, improve productivity of rice and fish cultivation, and introduce high value rabi crops to increase farm income and improve household nutrition.
4. **Collaborators:** Bangladesh - IRRI, BRAC, Bangladesh Agricultural University, Khulna University, Patuakhali Science and Technology University; Sher-e-Bangla Agricultural University; United States - Kansas State University, University of Arkansas
5. **Achievements (See FY 2020 Annual Work Plan Activity 4.4):**
  - The SILL-Polder team organized trainings for five Learning Hubs in Polder 30 on fertilizer and pest management, with a focus on rodent management in rice. A total of 55 men and women farmers participated in the training program.
  - The team identified four polders adjacent to Polder 30, where the findings of the SILL-Polder Project has the potential to be scaled-up for improving food security and income of the climate-vulnerable rural community.
  - The project provided training to 91 women farmers and women leaders in the southwest region on fertilizer and pest management in HYV rice, rabi crops cultivation on moist soil and management practices for higher yield and income, and importance of zinc-enriched rice, maize, mungbean and sunflower on household nutrition, especially on children and lactating women.
  - Empowerment of 17 male youth on cost-effective fertilizer and weed management in dry season cropping by using mini-tillers and encouraged them to develop as agri-entrepreneurs.
6. **Capacity Building:**
  - The project provided training to 1124 men and 1137 women (total 2261 men and women) farmers, members of water management organization, public representatives, mother of the school children and school teachers, and government officials working on agricultural technology dissemination on integrated crop and water management for year-round cropping, nutritional aspects of crops introduced by the project, service providers development in agricultural mechanization focusing on landless women and youth.
  - Provided nutritional awareness training to 348 mothers of the school children, schoolteachers and household members of the learning hubs in polder 30 to educate them on the nutritional crops introduced by the SILL-Polder Project. Among them, 80% were women.
7. **Lessons Learned:**
  - The main challenge is to organize the community-based water management emphasizing the hydrological area, not by geographical boundaries which is the current practice. Approaching this challenge based on hydrological units will help in wide-scale adoption of improved agricultural technologies in the polders of the coastal zone of Bangladesh.
  - The outputs of the SILL-Polder project are being adopted by organizations such as Blue Gold Program, jointly implemented by the Royal Dutch Government and Government of Bangladesh for upscaling key findings from the SILL-Polder project in the coastal zone of Bangladesh.
  - There is a large scope for the development of agri-entrepreneur for livelihood improvement of the poor women and landless youth at the same time sustaining agricultural growth in the polders of the coastal zone of Bangladesh.

- Sunflower cultivation in the dry season has attracted the interest of traders/millers to initiate contract farming in the polder region.
- The coastal zone of Bangladesh is blessed with huge tidal river water resources. Bangladesh can make a quantum leap in meeting future food security requirements utilizing the gift of nature.

#### 8. ***Presentations and Publications:***

- Yadav S, Mondal, MK, Shew A, Jagadish SVK, Khan ZH, Sutradhar A, Bhandari H, Humphreys E, Bhattacharya J, Parvin R, Rahman M, Chandna PK. (2020). Community water management to intensify agricultural productivity in the polders of the coastal zone of Bangladesh. Paddy and Water Environment, <https://doi.org/10.1007/s10333-019-00785-4>
- Bhattacharya J, Saha, NK, Mondal MK, Bhandari H, Humphreys E. (2019). The feasibility of high yielding aus-aman-rabi cropping systems in the polders of the low saline coastal zone of Bangladesh. Field Crops Research, 234, 33-46. <https://doi.org/10.1016/j.fcr.2019.01.007>
- Mondal M. (2019). An innovative water management approach for increasing land productivity in the polders of the coastal zone of Bangladesh. Natural Resource Management of the International Conference on Climate Knowledge, ICCCD Independent University, Bangladesh. - presentation
- Mondal MK, Yadav S, Jagadish SVK, Bhattacharya J, Parvin R, Sarker S, Vhadra A, Rahman M, Ray A, Parvin S, Khan ZK, Sutradhar A, Kamal FA. (2019). Land productivity improvement opportunities in the coastal polders to address food security challenges of Bangladesh. International conference on Sustainable Development, United International University, Bangladesh – presentation
- Mondal MK. (2019). An appropriate technology dissemination model for crop intensification in the coastal polders of Bangladesh. Keynote presentation at the Government's Department of Agricultural Extension (DAE) – presentation
- Assefa Y, Yadav S, Mondal MK, Bhattacharya J, Parvin R, Sarker SR, Rahman M, Sutradhar A, Prasad PVV, Bhandari H, Jagadish SVK. Crop diversification in rice-based systems in polders of Bangladesh. Agricultural Systems (In Press)
- Freed S, Barman B, Haque M, Kura Y, Tezzo X, Karim M, Cohen P, Gregory R, Stuart A, Funge-Smith S, Joffre O, Hadi B, McCartney M, Halwart M, Dubois M, Flor R, Jagadish SVK, Mondal M, Nguyen VK, Yadav S. (Under Review). Maintaining diversity of integrated rice and fish production confers adaptability of food systems to global change. Frontiers in Sustainable Food Systems.

## IX. Cambodia – WAgN (FY2016 – FY2020)

1. **Name:** Women in Agriculture Network (WAgN) Cambodia: Gendered- and Ecologically Sensitive Agriculture (PI: Ricky Bates, Pennsylvania State University)
2. **Locations:** Banan district (Battambang province), Puok district (Siem Reap), and Stung Chinit (Kampong Thom province)
3. **Description:** The WAgN Cambodia projects aims to empower women and improve nutrition by promoting women’s participation in the value chains for horticultural crops and rice produced via sustainable intensification (SI) practices. The overarching goal of the project is to provide a scientifically rigorous and comprehensive understanding of the nexus of gender and SI.
4. **Collaborators:** *Cambodia* - Asia Impact Center – ECHO, Royal University of Agriculture, Conservation Agriculture Service Center, University of Battambang; *Denmark* - Agricultural Development Denmark Asia (ADDA); *Thailand* - Kasetsart University; *United States* - University of Tennessee Institute of Agriculture; World Vegetable Center (AVRDC)
5. **Achievements (See FY 2020 AWP Activity 4.6):**
  - Submitted three manuscripts to peer-reviewed journals
  - Ms. Sovanneary Huot completed her PhD program at Penn State University, which focused on gender roles within Cambodian agricultural cooperatives.
  - Awarded \$175k grant to develop UBB capacity through the World Bank Higher Education Improvement Project as a direct result of the WAgN project.
  - Developed a nursery network focused on wild food plant propagation and distribution. One Battambang nursery is producing over 500 *Acacia pennate*, which will become a key component of wild gardens in the S3 Green Labs.
  - The WAgN team developed a successful proposal for the second phase of SIII titled *S3-Cambodia: Scaling Suitable Sustainable Technologies*. This proposed project features a prominent youth engagement component, focused on CE SAIN-partner high schools and vocational agriculture high schools across Cambodia (see below).
  - This project has been completed and has been closed out. Full results from the project will be highlighted in the SIII Five-Year Report.
6. **Capacity Building:**
  - None to report at this time.
7. **Lessons Learned:**
  - The need to pay close attention to social issues that impact project objectives, especially as some of these issues may initially appear unrelated. Youth outmigration is creating a myriad of issues negatively impacting agriculture in Cambodia, including labor shortages, lack of skilled personnel, erosion of indigenous knowledge relating to traditional agriculture systems. Knowledge is often traded and shared in communities along with germplasm. With youth leaving rural areas, the knowledge of traditional and wild plant species and their uses is at risk of being lost.
  - Lack of integration of cooperatives into research and collective action. Cooperatives could be ideal organizations with which we can scale technologies as they already have market access. Working with ADDA and the various USAID projects (HARVEST II) could be a way to engage them more.
  - 'Market pull' is critical to sustaining mid- and long-term gains related to projects with a "improving livelihoods" component. A challenge to scaling up SI technologies is the lack of an established system for linking project technologies (i.e. containerized grafted tomatoes) to retail markets (stores, nurseries).

- Understand local culture, including established practices that may affect project interventions and activities. In Battambang and Kampong Thom, a number of fields with cover crops were lost due to burning at night for hunting. These issues emphasized the need to strengthen collective action that should bring together not only targeted communities but also neighboring communities and the need of a clear economic model giving value to the cover crops used. This is challenging, and despite the progress made with the use of simulation game and participatory process, there are still a range of issues that have to be overcome. This result emphasized the need to invest into an assessment of the value chains of seeds of cover crops and/or other crop diversification process in order to bring immediate return (cash) to farmers.
- Challenges identified by WAgN involve various scales and domains. Often challenges at the farm level are easier to resolve than those at a national level. However, possible solutions and opportunities remain. Efforts to engage government (Ministry of Agriculture, Forestry, and Fisheries and Ministry of Education, Youth and Sport) were well-received, and more effective than anticipated. This governmental engagement holds real potential for future policy development and improvement.
- The value of developing lasting partnerships and networks within the focus country (Cambodia), as well as within various sectors of the agricultural development community. In the case of WAgN, during the past 4.5 years strong, effective, and active relationships have been forged with organizations such as ECHO Asia, the World Vegetable Center, UBB, RUA, CIRAD, and other actors. These networks hold the potential to improve, sustain, and hasten future work exponentially.

#### 8. **Presentations and Publications:**

- Ngang C, Pao S, Ader D, Tivet F, Bates R. (2020). Improving vegetable garden soil health in Cambodia through conservation agriculture. (In preparation – expected submission Dec. 2020).
- Bates R, Ader D, Gill T, Brown S. (2020). Role of underutilized wild food plants in small farm diversification in northwest Cambodia. (In preparation – expected submission Oct. 2020).
- Hav K, Ngang C, Srean P, Ader D, Bates R. (2020). Rainy-season performance of tomato grafted onto eggplant rootstocks in Cambodia. (In preparation – expected submission Nov. 2020).

## X. Cambodia – Scaling Suitable Sustainable (S3) Technologies (FY 2020 – FY 2023)

1. **Name:** S3-Cambodia: Scaling Suitable Sustainable Technologies (PI: David Ader, University of Tennessee)
2. **Locations:** Siem Reap, Kampong Thom, Battambang, Kampong Cham and Phnom Penh, Cambodia
3. **Description:** The Scaling Suitable Sustainable Technologies (S3-Cambodia) project will support agents to scale suitable and sustainable technologies in Cambodia. By employing the gender and ecologically sensitive impact pathways mapped during the 2015-2020 WAgN-Cambodia project, S3-Cambodia will advance the capacity and roles of scaling agents in technology diffusion through applied research, technical assistance, curricula development and organizational strengthening. This process will demonstrate the potential for and provide critical information on scaling technology through local, national and regional networks and for uptake of sustainable intensification (SI) technologies by rice-based farmers and others, serving as a regional model for self-reliance.
4. **Collaborators:** *Cambodia:* Royal University of Agriculture / Center of Excellence on Sustainable Agricultural Intensification, University of Battambang; *Switzerland/Cambodia:* Swiss Foundation for Technical Cooperation (Swisscontact); *France/Cambodia:* Centre de coopération internationale en recherche agronomique pour le développement (CIRAD); *Thailand:* ECHO Asia; *Philippines:* Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA); *USA:* University of Pennsylvania, Tennessee State University
5. **Key Achievements (See FY 2020 Annual Work Plan Activity 4.7):**
  - Contract finalization and project implementation preparation.
  - Recruited MS student in Agricultural Leadership, Education and Communications (ALEC) at the University of Tennessee. Gracie Pekarcik will support curriculum development for green labs and scaling research for S3-Cambodia.
  - S3 is working with the Ministry of Education, Youth and Sport on how to engage schools and create curriculum as a part of their pathways to scaling. They attended a conference where high school principals from all over Cambodia participated, and former SIIL-supported graduate student and current UBB technician was able to present S3's vision to the principals.
  - Another technician is working to expand the wild food plant nursery at the UBB campus.
6. **Capacity Building:**
  - *None to report for this period.*
7. **Lessons Learned:**
  - *Due to the disruptions to international travel, we expect to rely on our Cambodian-based partners more during the initial period of implementation.*
8. **Presentations and Publications:**
  - *None to report for this period.*

## Theme IV: Crop-Livestock Interactions – West Africa

### XI. Senegal

#### **Completed Project (FY 2016 – FY 2020)**

1. **Name:** Adoption of Sustainable Intensification in Dual-Purpose Millet - Leguminous Crops - Livestock Systems to Improve Food and Nutritional Security and Natural Resources Management for Rural Smallholder Farmers in Senegal (PI: Doohong Min, Kansas State University)
2. **Locations:** Louga, Diourbel, Kaffrine, Kédougou, Kolda and Sedhiou regions in Senegal
3. **Description:** The main objectives of this project are to: a) ensure food and nutritional security; b) establish resilient farming systems via a holistic approach for rural smallholder farmers, particularly women, and; c) improve nutritional and socioeconomic status in particular for women and children in the identified regions. These objectives will be achieved by using sustainably intensified production and management practices of dual-purpose millet and leguminous crops (cowpea and groundnut) with small ruminant livestock (goats and sheep) integration.
4. **Collaborators:** Senegal - Institut Sénégalais de Recherches Agricoles (ISRA) – Centre National de Recherches Agronomiques de Bambey (CNRA/Bambey), University of Thies, Institut de Technologie Alimentaire (ITA), Agence Nationale de Conseil Agricole et Rural (ANCAR), Le Réseau des Organisations Paysannes et Pastorales du Sénégal (RESOPP); France - Institut de Recherche pour le Développement (IRD) and CIRAD
5. **Key Achievements (See FY 2020 AWP Activity 4.8):**
  - Field days in Bambey and Passy were organized by Agence National de Conseil Agricole et Rural (ANCAR) and a workshop to share the dual-purpose millet trials was organized by farmer organization RESOPP (Réseau des Organisations Paysannes et Pastorales du Senegal) in Thies for local and lead farmers, co-PIs, RESOPP technicians (farmers' Co-Op), researchers, extension agents, and processors to provide capacity-building opportunities in the region.
  - As part of the development of millet for the manufacture of poultry feed, six (6) chicken coops were installed in the community of Malicounda. By using pearl millet seed by-products (hulls), women in the community were able to grow chickens, enabling them to generate extra income and provide animal-based protein to their families.
  - The biochemical analysis of the five varieties of millet carried out shows first that the introduced varieties (SL423 and SL169 particularly) are generally richer in carbohydrates, proteins and minerals than the references (Souna3 and Tchallack). It was noted that among the varieties introduced, SL423 and SL169 would be more suitable for making infant flours because their micronutrients, proteins and carbohydrate contents. Thus, SL423 would be more suitable against micronutrient (ferrous and zinc particularly) malnutrition, while SL169 would be more able to fight against protein-energy malnutrition.
- This project has been completed and has been closed out. Full results from the project will be highlighted in the SIIL Five-Year Report.
6. **Capacity Building:**
  - None to report at this time.
7. **Lessons Learned:**
  - Maintaining a good relationship with local and lead farmers by communicating with them and providing agriculture-based programs are very critical since the goal is to have these people eventually adopt the technologies as a part of their farming systems.
8. **Presentations and Publications:**
  - Faye, A. (2019). Development of a model to estimate the root length density of millet in the field to assess the response of the root system to drought, fertilization and sowing density under real conditions. Dissertation.



### **Extended Project (FY 2020 – FY 2023)**

1. **Name:** Improving food and nutrition security of smallholder agro-pastoral farming systems by integrating crop-livestock-human nutrition in Senegal and Niger (PI: Doohong Min, Kansas State University; Aliou Faye, ISRA)
2. **Locations:** Louga, Diourbel, Kaffrine, Kédougou, Kolda and Sedhiou regions in Senegal; Niamey and surrounding areas in Niger
3. **Description:** This project will focus on large-scale dissemination of three innovations (dual-purpose millet line stover for livestock feeding, best agronomic management practices for sustainable intensification of millet cropping systems, and fortifying millet-based products especially for pregnant women and children as well as promoting millet grain byproducts as chicken feed) to create more awareness and enhance human and animal food and nutrition while generating further income and nutritional outcomes for smallholder farmers in the targeted regions of Senegal and Niger. We believe that if we implement a farming systems approach then this will guide the dissemination of these technologies along the dissemination pathway and improve overall crop-livestock integration.
4. **Collaborators:** *Senegal* - Institut Sénégalais de Recherches Agricoles (ISRA) – Centre National de Recherches Agronomiques de Bambey (CNRA/Bambey), University of Thies - ENSA, Institut de Technologie Alimentaire (ITA), Agence Nationale de Conseil Agricole et Rural (ANCAR), Le Réseau des Organisations Paysannes et Pastorales du Sénégal (RESOPP), Bureau d'Analyse Macro Economiques (BAME), Peace Corps Senegal; *Niger* - Institut National de la Recherche Agronomique du Niger (INRAN/ CERRA-Maradi)
5. **Key Achievements:**
  - The women's organization, KEUR GUI, in Malicounda, produced over 200 kg of enriched flour with an average price of 1,000F CFA (US \$2.0) per kg and 400 kg of Thiackry with a price of 1,000 CFA (US \$2.0) per bag of 800 g.
  - Creation and implementation of seed production plots for dual-purpose millet varieties of Thialack2, SL28, SL169, and SL423 to compare them to Souna 3 at Niore and Bambey research stations.
  - On station feeding trial refining, including: implementation of experiments on rationing for the fattening of young bulls and millet production at ENSA, Implementation of millet farm for dual-purpose stover production, and the acquisition of concentrated animal feed and veterinary products for the coming feeding trial experiment.
6. **Capacity Building:**
  - Research supervision and thesis advising for 2 MSc students.
7. **Lessons Learned:**
  - None to report at this time.
8. **Presentations and Publications:**
  - None to report at this time.

## Theme V: Cereal and Legume Systems and Conservation Agriculture – East Africa

### XII. Tanzania

1. **Name:** Raising Crop Response: Bidirectional Learning to Catalyze Sustainable Intensification at Multiple Scales (PI: Sieglinde Snapp, Michigan State University)
2. **Locations:** Babati, Iringa rural, Mufindi, Wanging'ombe, Njombe rural, Songea rural, Mbeya rural, and Mbozi districts in Tanzania, Northern and Southern Highlands
3. **Description:** The project aims to improve family nutrition, reduce poverty, and enhance the use of environmentally-sound farming practices among smallholder farmers in East Africa. Specific project objectives include:
  - Generate improved agronomic knowledge of practices that sustainably raise maize and bean yields and crop response to inorganic fertilizer.
  - Evaluate bidirectional learning and effective extension approaches to promote SI technologies among researchers, extension, agrodealers, NGOs, and farmers.
  - Generate improved knowledge of the nutrition impacts of adoption of SI technologies through analysis of Tanzania household surveys.
  - Provide practical guidance to governments on staple food marketing, trade, and extension policies that support adoption of organic matter and SI technologies to support broader diffusion and scaling.
4. **Collaborators:** *Netherlands* - Wageningen University and Research Center; *Tanzania* - Sokoine University of Agriculture (SUA), CIAT, The Nelson Mandela African Institution of Science and Technology (NM-AIST), IITA, CIMMYT (TAMASA), N2Africa
5. **Achievements (See FY 2020 AWP Activity 4.9):**
  - A new policy on maize price regulation was developed and disseminated to over 150 policy makers, donors, advocacy groups and farmers unions.
  - Innovations in client-oriented extension include utilization of the LandPKS smartphone application to reach farmers with extension recommendations in the Southern Highlands, documented in a Land Development and Degradation published journal article.
  - A paper was submitted that documented current status and how to improve child feeding practices, based on a household survey and sampled food portions analyzed for aflatoxin: 'Monotonous Cereal Based Complementary Feeding Contributes to Aflatoxin Exposure in Children'.
  - This project completed its and is being closed out. Full results from the project will be highlighted in the upcoming SILL Five-Year Report.
6. **Capacity Building:**
  - 4 graduate students (3 women) continued with their graduate coursework and research proposal writing at their respective institutions. One graduated at the end of 2019 and the other 3 will graduate at the end of 2020.
7. **Lessons Learned:**
  - Data was not all collected in a manner that was straightforward to link up data sets, despite best efforts to ensure automatic linkages. Pigeon pea biomass data was collected on data sheets that were not uploaded on spreadsheets for over a year, but now are being completed.

- Communication with FIPS (the NGO) has proved challenging sometimes with few forms being completed, and it has been unclear by what criteria yield monitoring sites were chosen. FIPS has engaged in the report back workshop and is excited about findings that indicate the bean technologies are valued by farmers, and that baby packs added to mother demos are an effective way particularly to reach farmers that live in more remote areas, and are otherwise hard to engage, so this challenge is being addressed.

#### 8. **Presentations and Publications:**

- Nord A, Snapp S. (2019). Documentation of farmer perceptions and site-specific properties to improve soil management on smallholder farms. *Land Degradation and Development* (Accepted)
- Mugi E, Zingore S, Giller K. (2019). Farm-scale assessment of the determinants of productivity of maize - pigeonpea intercropping systems in Northern Tanzania. *Nutrient Cycling in Agroecosystems* (submitted)
- Fredrick R, Snapp S, Kassim N. (2020). Monotonous cereal based complementary feeding contributes to aflatoxin exposure in children. *Ecology and Nutrition* (submitted)
- Kim J. (2020). The effects of the national agricultural input voucher scheme on sustainable intensification of maize production in Tanzania. *Journal of Agricultural Economics* (submitted)
- Morgan S, Mason N, Maredia M. (2020). Lead-farmer extension and smallholder valuation of new agricultural technologies in Tanzania. *Food Policy*. (Under Review)
- Nord A, Bekunda M, Snapp S. (2020). The complex and often disconnected relationships between agricultural extension knowledge systems and farmer practice in Tanzania. *Food Policy*. (submitted)
- Nord A, Snapp S, Miller N, Mariki W. (2020). Investigating the diverse potential of a multi-purpose legume, *Lablab purpureus* (L.) sweet, for smallholder production in East Africa. *PlosONE* (published)

## VI. Associate Award Research Project Reports

### A. Feed the Future Policy Impact Study (Policy Research Consortium)

#### Award # SI9050/A00-1012-S001- Kansas State University

1. **Name:** Feed the Future Policy Impact Study (Policy Research Consortium) (Subaward PI: Cary Pray, Rutgers University)
2. **Locations:** Mainly global location due to the nature of the policy work, including country level programs and collaborators in Rwanda, Senegal, Nigeria and Malawi.
3. **Program Description:** The Feed the Future Policy Impact Research Study is a multi-institutional Consortium led by Rutgers University (RU) and operates as an associate award of the USAID funded Feed the Future Innovation Lab for Collaborative Research on Sustainable Intensification (SIIL). This Consortium supports the achievements of the U.S. Government Global Food Security Strategy objectives through contributing to the improvement of policy approaches and outcomes. It also supports the learning agenda on policy, systems analysis, and implementation and assists the initiative to report on the success of its efforts. The aims of the Consortium are to develop a clearer understanding of contemporary agricultural and structural transformation, to develop and utilize specific set of indicators to quantify the impact or progress of key Global Food Security goals, and understand how agricultural and food policies help to enable and contribute to agricultural transformation.
4. **Collaborators:** Collaborators for the Policy Research Consortium include the International Fertilizer Development Center (IFDC), Michigan State University, Montana State University, Northwestern University, Tufts University, University of Florida, African Economic Research Center, University of Rwanda and Université de Gaston-Berger.
5. **Key Achievements:**
  - The Consortium began FY 2020 by organizing a workshop and listening session on October 28-29, 2019. This two-day event held at the National Press Club in Washington examined the role of policy change in contemporary agricultural transformation and the use of evidence in understanding and influencing policy change. On the first day, consortium members made presentations related to their research activities to a group consisting largely of USAID BFS staff. On the second day, consortium members held separate sessions with the USAID staff and leadership to understand the programmatic and policy needs, especially with respect to the four new Centers (agriculturally led growth, nutrition, water, and resilience) under the new Bureau for Resilience and Food Security (RFS). The discussion with USAID allowed consortium members to identify: (1) policy changes that were influenced by USAID activities and had important impacts on food and agriculture in Feed the Future countries; (2) policies that block the impact of USAID programs; (3) methods that have been used to generate the political will to change policies; and (4) ways in which the final year of the Consortium's work can be made most useful to USAID.
  - The Consortium is in the process of following up with USAID on how to reorient some of its research and programmatic activities to better meet the needs of the new Centers. Among the activities planned are further engagement with the Centers to help them answer some of the pressing policy questions that were asked. A list of these questions and draft conference report is provided.

- With the onset of the COVID-19 situation, a number of Consortium members responded to requests from USAID staff to develop a set of policy guidelines on how best to address the COVID-19 induced disruption on agri-food systems in developing countries but specifically on Feed the Future countries. The guidance and associated policy matrix were made available to USAID Missions so that they could use it to understand the policy choices in dealing with COVID-19. Currently, the policy guidance is being adapted into a document/publication that could be shared more widely. The broader policy guidance will provide evidence on the types of measures that governments can implement to safely keep food markets open and functioning.
- The Consortium's support to Dr. Sera Young at Northwestern and the HWISE indicator has made considerable progress. IFPRI has decided to implement the short form of the HWISE scale in panel surveys about COVID-19 impacts in 8 countries. Some of these surveys are funded by USAID. We will begin analyzing those data this week. In about 30 minutes I'll be presenting on HWISE at the UN World Data forum. Oxfam is implementing HWISE to evaluate impacts of a variety of their programs, and the first data from Sierra Leone show a huge decrease in HWISE scores in the sites with the intervention.
- The COVID-19 surveillance project is also progressing well and making a significant impact to inform We are hoping to have the opportunity to showcase this product to Missions and partnering countries. In the end, our biggest impact is that we can inform leaders and public health advisors about when the pandemic is shifting, when and where it is accelerating, and when there is the potential for explosive growth, we can inform public health policy which differs from public policy in that it is more useful for the prevention of morbidity and mortality.
- The Consortium has also successfully shifted many of its activities towards more COVID-19 related issues. Notable among them is the COVID-19 surveillance work that is being done by Lori Post and colleagues at Northwestern which provides a proof of concept on how to create a surveillance metric that corrects for measurement error and data contamination to determine when it is safe to reopen in various countries.
- During much of September and October, Consortium members including colleagues from USAID and KSU/SIIL engaged in weekly planning meetings via phone. Initiations were sent to nearly 50+ individuals from within USAID as well as partners in the World Bank and IFPRI. Nearly all US-based Consortium members attended the meeting and actively participated in the discussions. In preparation for the meeting, Consortium members wrote eight new policy briefs for distribution at the event (available at [ru-fff.rutgers.edu](http://ru-fff.rutgers.edu)).

## 6. **Capacity Building:**

The Consortium has various students that work with researchers as RAs and are reported in Section I. Our main capacity building activity is through our collaborator the African Economic Research Consortium where we have supported (via a sub-award to AERC) the thesis writing stage of the 7 students enrolled in the Combined Masters in Agricultural and Applied Economics (CMAAE) program.

## 7. **Lessons Learned:**

- Engagement with USAID staff especially mission staff as was done during the listening sessions is very informative and helps keep the Consortium's work relevant.
- USAID staff expressed great interest and demand for policy work, but it needs to be presented in short easy to understand policy briefs.

- Providing specific examples of successful policies will assist mission staff to better make the case for policy change within countries.
- Within the seed policy work, the need to understand constraints to adoption of newer varieties and the reasons of slow varietal turnover. Yields have increased, but role of new varieties is unclear, and new varieties likely not being adopted. Policy reforms have resulted in greater private sector participation and varietal (e.g. Kenya).
- The daily cost of recommended diets, meeting dietary guidelines in terms of food groups to avoid cardiometabolic diseases such as diabetes and hypertension, is even higher than the cost of essential nutrients, demonstrating the urgent need for food system productivity growth to raise incomes and lower prices.
- Both indicators vary over time and space showing systematic differences in the ability of food systems to bring healthy diets within reach of the poor, providing a useful new metric linking agricultural transformation to development goals in nutrition and health.
- The daily cost of nutrient adequacy, providing sufficient protein, lipids and micronutrients for lifelong health, would exceed total expenditure on all goods and services for most people in low-income countries; for them, low diet quality is caused by low income and high food prices, rather than food choice or nutrition knowledge.

## 8. **Presentations and Publications:**

### *Journal Publications*

- 1) Bai Y, Alemu R, Block SA, Headey D, Masters WA. (2020). Cost and affordability of nutritious diets at retail prices: Evidence from 177 countries. *Food Policy*, forthcoming. <https://doi.org/10.1016/j.foodpol.2020.101983>
- 2) Bell W, Coates J, Masters WA, Wilson N. (2020). Measuring consumer preferences in changing food environments: a methods review. *Current Developments in Nutrition*, 4(S2): 1160. [https://doi.org/10.1093/cdn/nzaa056\\_007](https://doi.org/10.1093/cdn/nzaa056_007)
- 3) Boateng GO, Workman CL, Miller JD, Onono M, Neilands, TB, Young SL. (2020). The syndemic effects of food insecurity, water insecurity, and HIV on depressive symptomatology among Kenyan women. *Social Science and Medicine*, pp.113043-113043. <https://doi.org/10.1016/j.socscimed.2020.113043>
- 4) Brewis A, Workman C, Wutich A, Jepson W, Young S, Household Water Insecurity Experiences–Research Coordination Network (HWISE-RCN), Adams, E., Ahmed, J.F., Alexander, M., Balogun, M. and Boivin, M. (2020). Household water insecurity is strongly associated with food insecurity: Evidence from 27 sites in low-and middle-income countries. *American Journal of Human Biology*, 32(1), p.e23309. <https://doi.org/10.1002/ajhb.23309>
- 5) Choudhury S, Headey D, Masters WA. (2019). First foods: Diet quality among infants aged 6–23 months in 42 countries. *Food Policy*, 88 (Oct):101762.
- 6) Finaret AB, Masters WA. (2019). Beyond calories: The new economics of nutrition. *Annual Rev. of Res. Econ.* 11 (Oct): 14.1-23.
- 7) Miller JD, Vonk J, Staddon C, Young SL. (2020). “Is household water insecurity a link between water governance and well-being? A multi-site analysis.” *Journal of Water, Sanitation and Hygiene for Development*. 10 (2): 320–334. doi: <https://doi.org/10.2166/washdev.2020.165>
- 8) Thavarajah W, Verosloff MS, Jung JK. et al. (2020). A primer on emerging field-deployable synthetic biology tools for global water quality monitoring. *npj Clean Water* 3, 18 (2020). <https://doi.org/10.1038/s41545-020-0064-8>



### Blogs

- 1) Bai Y, Masters WA. (2020). Retail food prices at purchasing power parity exchange rates: A first look at aggregate ICP 2017 data. World Bank data blog (<https://blogs.worldbank.org>).
- 2) Masters WA, Bai Y, Headey D, Hirvonen K. (2019). Can the world's poor afford a healthy diet? VoxDev blog (<https://voxdev.org>).
- 3) Nagarajan L, Naseem A, Pray C. (2020). "Seed Policy Reforms in Zambia" AgriLinks Blog <https://www.agrilinks.org/post/seed-policy-reforms-zambia>

### Police Briefs

- 1) Anderson JR. (2020). "A Brief 2020 Vision of Agricultural Advisory Services Policy"
- 2) Anderson JR, Pray CE, Naseem A, Oehmke J. (2019) "From Green Revolution to Contemporary Agricultural Transformation"
- 3) Nagarajan L, Naseem A, Pray CE. (2019) "Contribution of Policy Change on Maize Varietal Development and Yields in Kenya"
- 4) Masters WA, Wilson N, Weatherspoon D. (2019). "Policy change for improved nutrition: Summary of Lessons Learned"
- 5) Masters WA, Wilson N. (2019). "Cost of nutritious diets as a policy indicator for agricultural transformation and healthy food systems"
- 6) Masters WA, Wilson N. (2019). "Impacts of Policy Change: Infant Cereals in Malawi"
- 7) Raile E, et. al. (2019). "Political will and Public Will for climate-smart agriculture in sub-Saharan Africa"
- 8) Slaymaker T, Johnston R, Young S, Miller J, Staddon C. (2020). WaSH Policy Research Digest Issue #15, June 2020: Measuring Water Insecurity Detailed Review of a Recent Publication: An innovative measure of the experience of water insecurity can help identify vulnerable households and evaluate interventions
- 9) Weatherspoon D. et al (2019). "Nutrition, food security, markets and food policy in Rwanda"
- 10) Young SL. (2019). "A novel tool for measuring progress towards global water security: health, agriculture, and policy implications"

### Working Papers

- 1) Gilbert R, Subedi B, Wallingford J, Wilson N, Masters WA. (2019). Nutrient and Mycotoxin Content of Commercially Sold Premixed Infant Cereals in Malawi, MSS Working Paper 28. Washington, DC: International Food Policy Research Institute. News: <https://mwnation.com/poor-market-surveillance-poses-threat-to-baby-feed-study>.
- 2) Herforth A, Bai Y, Venkat A, Mahrt K, Ebel A, Masters WA (2020). Cost and affordability of healthy diets across and within countries. Background paper for the State of Food Security and Nutrition in the World 2020

### Presentations

- 1) Anderson J. (2020) "The future will be like the past... :Is agricultural extension exceptional?" Envisioning the Future of Extension, IFPRI, Washington March 4-5, 2020.
- 2) Masters WA. (2020) "Can low-income people afford a healthy diet? New price indexes to measure food system change." Seminar with FAO country representatives (by video to Rome and worldwide, 22 May 2020)
- 3) Masters WA. (2020). "Can low-income people afford a healthy diet? New price indexes to measure food system change." Seminar for UKAid economists (by video to London and worldwide, 30 March 2020).
- 4) Masters WA. (2020). "The cost and affordability of the EAT–Lancet reference diet." ANH Academy (by video, 4 Dec 2019).

- 5) Moss CB, Oehmke JF, Nsabimana A, Naseem A. (2020). “Resilience and Persistence of a Policy Intervention: An Analysis of the Effect of SPREAD in Rwanda” Presented at the annual meetings of the AAEA, Kansas City, August 2020
- 6) Nsabimana A, Niyitanga F, Weatherspoon D, Naseem A. (2020). “Land Policy and Food Prices: Evidence from a Land Consolidation Program in Rwanda” To be presented at the annual meeting of ICABR (was scheduled for June 2020, but to be held virtually in October 2020)
- 7) Pray CE. (2020). “National and local policy interventions to support trade, food markets and enterprises” Food Security and Nutrition in the Context of COVID-19: Impacts and Interventions, BIFAD 181st Public Meeting, Washington DC, 2020.
- 8) Young SL. et al. Metropolitan & Household Water Insecurity: Novel Tools for Achieving SDG6. Stockholm World Water Week
- 9) Young SL, Staddon C. (2019). The Household Water Insecurity Experiences Scale: a simple questionnaire for generating high-resolution data on water security. Cairo Water Week. Cairo, Egypt. October 2019. (Oral presentation)
- 10) Young SL. (2019). Development and testing of a household water insecurity measure that is equivalent across countries. Agriculture, Nutrition & Health Academy Annual Meeting. Hyderabad, India. June 2019. (Oral presentation)
- 11) Young SL, Whinner J, Miller J, Staddon C, & HWISE Research Coordination Network. (2019). Development of a cross-culturally validated scale to measure household water insecurity experiences and implementation in urban, cholera-prone areas of Lusaka, Zambia. Water and Health Conference. Chapel Hill, NC. October 2019. (Oral presentation)

## VII. Human and Institutional Capacity Development

### Short-term training

Country of Training	Brief Purpose of Training	Who was Trained	Number Trained		
			M	F	Total
Bangladesh	Training on mechanical harvesting of rice in aman season 2019	Producers	36	42	78
Bangladesh	Refresher advanced training on harvesting technologies for operator, mechanics, workshop owners and progressive farmers in Dumuria, Khulna	Producers, Private Sector	10	0	11
Bangladesh	Refresher Advanced training on harvesting technologies for operator, mechanics, workshop owners and progressive farmers in Kolapara, Patuakhali	Producers, Private Sector	10	0	10
Bangladesh	Refresher Advanced training on harvesting technologies for operator, mechanics, workshop owners and progressive farmers in Subarnchar, Noakhali	Producers	7	17	10
Bangladesh	Refresher Advanced training on harvesting technologies for operator, mechanics, workshop owners and progressive farmers in Wazirpur, Barishal	Producers	21	1	10
Bangladesh	Training on Rice transplanter seedling raising in Dumuria, Khulna	Producers, Private Sector	10	1	14
Bangladesh	Field day on Rice transplanter at Boratia, Dumuria, Khulna	Producers, Civil Society	18	1	24
Bangladesh	Field day on Rice transplanter at Kulbaria, Dumuria, Khulna	Producers, Private Sector	9	1	22
Bangladesh	Field day on Rice transplanter at Wazirpur, Barishal	Producers	10	4	19
Bangladesh	Hands on training on Soybean planting using CA machinery in Noakhali	Producers, Private Sector	8	2	10
Bangladesh	Hands on training on mungbean planting using CA machinery in Patuakhali	Producers	0	30	10
Bangladesh	Hands on training on Mungbean planting using CA machinery in Barishal	Producers, Government, Private Sector	8	2	10
Bangladesh	Women Entrepreneurship and Gender Development Training	Producers, Private Sector	8	2	30
Bangladesh	Hands on training on seedling raising and transplanting at Baratia, Dumuria, Khulna	Producers	7	5	12
Bangladesh	Hands on training on seedling raising and transplanting at Holdibaria, Kalapara, Patuakhali	Producers, Government	12	2	14
Bangladesh	Hands on training on seedling raising and transplanting at Mundopasa, Wazirpur, Barishal	Producers, Government	13	15	15
Bangladesh	Virtual workshop on course curricula and syllabus overview and lecture plan update of FPM courses (BSc and MS)	Producers	8	2	15
Bangladesh	Introductory training course on rural invest at Zoom online platform	Producers	9	1	33
Bangladesh	Hands-on training on "transplanting, harvesting and seed planting machines" at Kalapara, Patuakhali	Civil Society	13	2	13

Country of Training	Brief Purpose of Training	Who was Trained	Number Trained		
			M	F	Total
Bangladesh	Hands-on training on "transplanting, harvesting and seed planting machines" at Wazirpur, Barishal	Producers	13	2	15
Bangladesh	Hands-on training on "transplanting, harvesting and seed planting machines" at Dumuria, Khulna	Producers	13	2	18
Bangladesh	Training on gender sensitization at Dumuria, Khulna	Producers, Government	11	2	16
Bangladesh	Training on gender sensitization at Wazirpur, Barishal	Producers	8	2	16
Bangladesh	Training on gender sensitization at Wazirpur, Barishal	Civil Society	26	7	16
Bangladesh	Refresher training on CA & WM Machinery for agricultural machine operator at Dumuria, Khulna	Producers	8	2	10
Bangladesh	Refresher training on CA & WM Machinery for agricultural machine operator at Dumuria, Khulna	Producers	6	10	10
Bangladesh	Refresher training on CA & WM Machinery for agricultural machine operator at Kolapara, Patuakhali	Producers	7	9	10
Bangladesh	Refresher training on CA & WM Machinery for agricultural machine operator at Wazirpur, Barishal	Producers	8	8	10
Bangladesh	Refresher training on CA & WM Machinery for agricultural machine operator at Wazirpur, Barishal	Producers	10	0	10
Burkina Faso	Annual animal nutrition training	Producers	370	58	428
Burkina Faso	Artisan training, forage chopper manufacture	Private Sector, Civil Society	6	0	6
Burkina Faso	Training of trainers: forage chopper tuning and guard manufacture	Private Sector	4	0	4
Cambodia	Tomato grafting for rainy season production	Producers, Government	13	11	24
Cambodia	Conservation agriculture principles	Producers	10	8	18
Cambodia	Seed system management	Producers, Government, Private Sector, Civil Society	18	4	22
Cambodia	Field visit of Sansam Mlub Prey's farmers group who produce wildlife's friendly organic rice in Preah Vihear province at the experimental site and CA farmers' network in Stung Chinit irrigation scheme.	Producers, Government, Civil Society	9	4	13
Cambodia	Perception of farmers on cover crops establishment for soil fertility and fodder resources improvement in the dry season and future plan toward CA transition	Government, Private Sector, Civil Society	10	3	13
Cambodia	Perception of farmers on cover crops establishment for soil fertility and fodder resources improvement in the dry season and future plans toward CA transition	Producers, Government, Private Sector, Civil Society	16	2	18

Country of Training	Brief Purpose of Training	Who was Trained	Number Trained		
			M	F	Total
Cambodia	Field day in Banan district, Battambang province	Producers, Government, Private Sector, Civil Society	65	9	74
Cambodia	Field trip of 2nd year students for the academic year 2019-2020 of Faculty of Agricultural Engineering (FAE)/RUA	Producers, Government, Private Sector	20	5	25
Cambodia	Field trip of 3rd year students of FAE/RUA for the academic year 2019-2020	Producers	21	10	31
Cambodia	The 6th Hub Advisory Committee meeting	Civil Society	30	6	36
Cambodia	Farming systems for sustainable agriculture	Producers, Government, Private Sector, Civil Society	23	34	57
Cambodia	Sustainable agricultural practices	Producers, Civil Society	10	10	20
Cambodia	Open system machinery in cambodia	Producers, Government, Private Sector, Civil Society	18	1	19
Cambodia	IPM and fertilizer management	Civil Society	8	10	18
Cambodia	Anti-microbial resistance and biosecurity	Government, Civil Society	27	5	32
Cambodia	SWAT and agricultural practices	Civil Society	33	18	51
Cambodia	Farm Management	Civil Society	24	18	42
Cambodia	Research methodology and data collection	Civil Society	11	17	28
Cambodia	Irrigation system for crop production	Producers, Private Sector, Civil Society	19	19	38
Cambodia	Sustainable crop production in agricultural technology park (ATP)	Civil Society	14	2	16
Cambodia	4S training (Social Media Marketing Session)	Private Sector Partners	5	3	8
Cambodia	Training of Trainers on CA practice	Farmers, private sector, government	40	12	52
Cambodia	Training of Trainer on CA practice_FAO	Farmers, private sector and government	16	8	24
Cambodia	Feedback using cover crops for soil improvement, planting green, soil erosion assessment CA & CT, using NT planter	NGO, farmers, Governmental officers (GDA/DAEng)	48	13	61
Cambodia	Cover crops establishment after rice in the lowlands of Banan	Farmers	33	1	34
Cambodia	Demonstrate land leveler and no-till cassava planter for increase productivity and move forward CA practicing	Farmers, service providers, Private Sector	15	5	20
Cambodia	Mission by GDA, AFD, MoWRAM	Private Sector	20	5	25
Cambodia	To learn CA practices and capacity building of students on machineries for CA.	Civil Society	12	8	20
Cambodia	Scaling up CA through 4S model, step S2 (provide the training for CA practices and connection to medium scale farmers and service provider)	Producers, Private Sector, Government Officials	52	29	81
Ethiopia	Manufacturing of animal feed chopper and grinder	Producers, Government, Private Sector, Civil Society	9	4	13
Ethiopia	Nutrition and food safety	Government	12	8	20
Ethiopia	Bookkeeping and saving for farmers	Producers, Government	20	15	35

Country of Training	Brief Purpose of Training	Who was Trained	Number Trained		
			M	F	Total
Ethiopia	Maji pump preventive maintenance and service	Producers, Government	19	14	33
Ethiopia	Conservation agriculture practices: benefits and constraints	Producers, Government	21	15	36
Ethiopia	Water lifting technologies and agricultural water management rools	Producers, Civil Society, Private Sector	21	15	36
Ethiopia	Training on nutrition for farmers	Producers, Government	28	27	55
Ethiopia	Fabrication of motorized maize sheller	Government, Private Sector	10	4	14
Ethiopia	Motorized maize sheller operation and preventive maintenance	Private Sector	7	3	10
Senegal	Sharing results workshop	Producers, Government, Private Sector	27	11	38
<b>Total</b>			<b>1521</b> (71%)	<b>628</b> (29%)	<b>2139</b>

## Long-term training

The following table reports all U.S. citizens/permanent residents and third country nationals that are currently receiving SIIL funds through consortia, research subaward projects, associate award or buy-in awards. The total number of degree seeking students is 75 with 45% females. There are 29 PhDs (38% F), 31 M.S.'s (58% F), and 15 Bachelor's (33% F).

Coded Name	Sex	University	Degree	Major	Program End Date (month/year)	Degree Granted (Y/N)	Home Country
1	F	Bangladesh Agricultural University	Ph.D.	Gender Research (Women's Engagement)	June 2020	Y	Bangladesh
2	M	Bangladesh Agricultural University	M.S.	Agricultural Engineering	November 2020	N	Bangladesh
17	M	Sylhet Agricultural University	Ph.D.	Agricultural Engineering	June 2020	Y	Bangladesh
22	M	Bangladesh Agricultural University	M.S.	Agricultural Engineering	November 2020	N	Bangladesh
32	M	Bangladesh Agricultural University	Ph.D.	Agricultural Engineering	June 2020	Y	Bangladesh
36	M	Bangladesh Agricultural University	Ph.D.	Water Governance and Management	June 2020	Y	Bangladesh
53	M	Bangladesh Agricultural University	Ph.D.	Agricultural Engineering	June 2020	Y	Bangladesh
55	M	Bangladesh Agricultural University	M.S.	Agricultural Engineering	November 2020	N	Bangladesh



<b>Coded Name</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>
6	F	Institute of Rural Development/Nazi Boni University	M.S.	Agricultural Engineering	December 2019	Y	Burkina Faso
10	M	Institute of Rural Development/Nazi Boni University	M.S.	Agricultural Engineering	December 2019	Y	Burkina Faso
25	F	Institute of Rural Development/Nazi Boni University	M.S.	Agricultural Engineering	December 2019	Y	Burkina Faso
51	M	Institute of Rural Development/Nazi Boni University	M.S.	Agricultural Engineering	December 2019	Y	Burkina Faso
71	F	Institute of Rural Development/Nazi Boni University	M.S.	Agricultural Engineering	June 2020	Y	Burkina Faso
9	M	Royal University of Agriculture	M.S.	Crop Science	January 2021	N	Cambodia
18	F	Royal University of Agriculture	M.S.	Animal Science	January 2021	N	Cambodia
19	M	Royal University of Agriculture	Ph.D.	Agricultural Engineering	June 2021	N	Cambodia
27	M	Royal University of Agriculture	M.S.	Crop Science	January 2021	N	Cambodia
34	F	Royal University of Agriculture	M.S.	Crop Science	January 2021	N	Cambodia
35	F	Royal University of Agriculture	M.S.	Food Science & Technology	January 2021	N	Cambodia
39	F	Royal University of Agriculture	M.S.	Crop Science	January 2021	N	Cambodia
41	F	Royal University of Agriculture	Ph.D.	Agro-Industry	June 2021	N	Cambodia
42	M	Royal University of Agriculture	Ph.D.	Agricultural Engineering	June 2021	N	Cambodia
44	M	Royal University of Agriculture	Ph.D.	Agribusiness	June 2021	N	Cambodia
45	M	Royal University of Agriculture	Ph.D.	Animal Science	June 2021	N	Cambodia
50	F	Royal University of Agriculture	M.S.	Animal Science	January 2021	N	Cambodia
59	M	Royal University of Agriculture	Ph.D.	Land Management	June 2021	N	Cambodia
68	F	Royal University of Agriculture	M.S.	Crop Science	July 2020	Y	Cambodia
63	F	Royal University of Agriculture	B.S.	Agro-Industry	December 2020	N	Cambodia
65	M	Royal University of Agriculture	Ph.D.	Food Science	June 2021	N	Cambodia
48	M	Royal University of Agriculture	B.S.	Agro-Industry	December 2020	N	Cambodia

Coded Name	Sex	University	Degree	Major	Program End Date (month/year)	Degree Granted (Y/N)	Home Country
69	M	Royal University of Agriculture	B.S.	Agro-Industry	December 2020	N	Cambodia
20	M	Royal University of Agriculture	B.S.	Agronomy	December 2020	N	Cambodia
26	F	Royal University of Agriculture	B.S.	Agronomy	December 2020	N	Cambodia
7	M	Royal University of Agriculture	B.S.	Agronomy	December 2020	N	Cambodia
28	M	Royal University of Agriculture	B.S.	Agricultural Engineering	December 2020	N	Cambodia
23	F	Royal University of Agriculture	B.S.	Agricultural Engineering	December 2020	N	Cambodia
60	F	Royal University of Agriculture	B.S.	Agricultural Engineering	December 2020	N	Cambodia
5	M	Royal University of Agriculture	B.S.	Animal Science	December 2020	N	Cambodia
52	M	Royal University of Agriculture	B.S.	Animal Science	December 2020	N	Cambodia
46	F	Royal University of Agriculture	B.S.	Veterinary Medicine	December 2020	N	Cambodia
57	M	Royal University of Agriculture	B.S.	Veterinary Medicine	December 2020	N	Cambodia
58	M	Royal University of Agriculture	B.S.	Agro-Industry	December 2020	N	Cambodia
43	F	Royal University of Agriculture	M.S.	Agronomy	December 2021	N	Cambodia
8	F	University of Battambang	M.S.	Sustainable Agriculture	February 2020	Y	Cambodia
21	F	Penn State University	M.S.	Rural Sociology	March 2020	Y	Cambodia
47	M	University of Battambang	B.S.	Agriculture	May 2021	N	Cambodia
62	M	University of Battambang	M.S.	Horticulture	May 2020	Y	Cambodia
3	F	Bahir Dar University	Ph.D.	Post-Harvest Technology	June 2020	Y	Ethiopia
12	M	Bahir Dar University	M.S.	Irrigation Eng. and Management	September 2020	Y	Ethiopia
15	F	Bahir Dar University	M.S.	Food Engineering	June 2020	Y	Ethiopia
24	M	Bahir Dar University	M.S.	Hydrology Engineering	December 2019	Y	Ethiopia
38	F	Bahir Dar University	M.S.	Gender and Development	September 2020	Y	Ethiopia
49	F	Bahir Dar University	M.S.	Post-Harvest Technology	October 2020	N	Ethiopia
61	M	Bahir Dar University	Ph.D.	Agricultural Mechanization Engineering	June 2022	N	Ethiopia
70	M	Bahir Dar University	M.S.	Industrial Engineering	September 2020	Y	Ethiopia

<b>Coded Name</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>
73	F	University of Nairobi	M.S.	Agricultural Economics	June 2020	Y	Kenya
77	F	Rutgers University	Ph.D.	Geography	May 2021	N	Nigeria
4	M	University of Thies (ENSA)	Ph.D.	Animal Science	June 2020	Y	Senegal
11	M	Chiekh Anta Diop University	Ph.D.	Soil Fertility	March 2020	Y	Senegal
13	F	Chiekh Anta Diop University	Ph.D.	Agronomy	October 2019	Y	Senegal
29	F	Chiekh Anta Diop University	Ph.D.	Food Processing and Nutrition	June 2020	Y	Senegal
30	F	University of Gaston Berger	M.S.	Agricultural Engineering	December 2020	N	Senegal
31	F	Chiekh Anta Diop University	Ph.D.	Agronomy	March 2021	N	Senegal
37	M	University of Thies	Ph.D.	Agricultural Economics	March 2023	N	Senegal
64	F	University of Thies	Ph.D.	Agronomy	December 2020	N	Senegal
67	M	University of Thies (ENSA)	Ph.D.	Soil Fertility	June 2020	Y	Senegal
14	F	Nelson Mandela African Institute of Science and Technology, Tanzania	M.S.	Nutrition	December 2020	N	Tanzania
16	M	Sokoine Educational Institution	Ph.D.	Soil Science	December 2020	N	Tanzania
33	F	University of Wageningen	Ph.D.	Agricultural Systems	December 2020	N	Tanzania
74	F	Sokoine University of Agriculture	M.S.	Agricultural Economics	June 2020	Y	Tanzania
72	M	Makerere University	M.S.	Agricultural Economics	June 2020	Y	Uganda
40	F	Michigan State University	Ph.D.	Agro-Ecology	December 2019	Y	United States
76	M	Rutgers University	Ph.D.	Geography	May 2021	N	United States
75	M	University of Zimbabwe	M.S.	Agricultural Economics	June 2020	Y	Zimbabwe

## Institutional Development

**CE SAIN Institutional Development:** The CE SAIN also continues to build human and institutional capacity at the Royal University of Agriculture in Cambodia. The CE SAIN implements its scholarship and research grant program to increase faculty teaching, research, and extension capacity through long-term training and degree enhancement. The Center, through its five Technology Parks, has also played a key role in linking RUA faculty and students and the private sector, NGOs, Innovation Labs, and other networks. These partnerships support the promotion of information dissemination and serve as a catalyst for new innovations.

*Partnerships: Cambodia* - Conservation Agriculture Service Center (CASC); Ministry of Agriculture Forestry and Fisheries (MAFF); Ministry of Education, Youth, and Sport (MoEY); Department of Agricultural Engineering (DAEng); Royal University of Agriculture - Phnom Penh; University of Battambang; and multiple Feed the Future Innovation Labs (e.g. Horticulture; Livestock Systems; Integrated Pest Management); and Swisscontact. Additional collaborators due to the ASA CAST (Commercialization of Aquaculture for Sustainable Trade) project include American Soybean Association, World Vision, and Auburn University.

**Institutional Sustainability:** The regional coordinators funded in Senegal and Burkina Faso have also helped with continuing some of the critical research initiated by the NARS (ISRA and INERA) and supported institutional capacity building to sustain long-term research. They will continue to collaborate with national and regional organizations, especially as the iREACH initiative begins their implementation phase.

*Partnerships: Senegal* - Mathematica (project on Sustainable Agricultural Decision Tools, AICCRA with International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) on climate resilient technology dissemination; *Cambodia* - Texas A&M University, University of Virginia, Royal University of Phnom Penh, WorldFish Malaysia, Cleber (private company, manufactures Oggun tractors), USDA ARS National Soil Dynamics Lab, Danfoss Hydraulics, SEARCA, Institute of Technology – Cambodia, Swiss Federal Institute of Aquatic Science and Technology (EAWAG).

## VIII. Innovation Transfer and Scaling Partnerships

### Plan of Action

The SIIL supported the creation, testing and scaling of 24 technologies during FY 2020, 9 of which were made available for uptake or have already shown adoption by the public and private sectors. During this reporting period, SIIL's project partners have done worked with numerous organizations, institutions, farming groups and local artisans to create, scale up and extend their various innovations.

#### Steps Taken

- CE SAIN worked to develop various improved conservation agriculture practices in conjunction with the University of Tennessee, UC Davis, and several Feed the Future Innovation Labs. Additionally, they demonstrated these practices to the government, the public and private sectors, as well as high school and college students at the Royal University of Agriculture supported tech parks in Cambodia.
- The Polder project in Bangladesh worked with several local universities, the International Rice Research Center (a CGIAR institution) and a NARS centers to create an innovate cropping pattern that would allow for more sustainable rice production in the polder region. Using field days, trainings and hands-on workshops, the project was able refine the planting technique and make it available to wider region for uptake.
- The WAgN project used support from local and international NGOs and partnered with CE SAIN to increase sustainable intensification and conservation agricultural practices, including the Wild Gardens concept (using indigenous plants to increase food and nutritional security), an innovative grafting technique to allow tomatoes to be grown through the rainy season, and a method for using “green manure” and relay cropping to increase soil fertility.
- The ASMC I worked with private sector motor companies, the Department of Agricultural Extension, the Bangladesh Agricultural Research Institute and the Bangladesh Agricultural University to create, fund, and extend their rice harvesters and transplanter.

#### Partnerships Made:

- **ASMC:** Bangladesh Agricultural University (BAU), ACI Motors Ltd., Metal Pvt Ltd., Department of Agriculture Extension (DAE) subsidy program, Bangladesh Agricultural Research Institute (BARI), Bangladesh Rice Research Institute (BRRI)
- **CE SAIN:** Horticulture IL (UC Davis), Livestock Systems IL (University of Florida), Project Everest, University of Tennessee
- **Unlocking the production potential of polder communities in Bangladesh:** Bangladesh Agricultural research Council (BARC), International Rice Research Institute (IRRI), local public universities
- **WAgN:** Agriculture Development Denmark Asia (ADDA), Conservation Agriculture Service Center (CASC), Centre de Coopération Internationale en Recherche Agronomique pour le Développement (CIRAD), CE SAIN, ECHO Asia, Kasetsart University, World Vegetable Center

#### Technology Ready to Scale:

- **ASMC:** Rice Transplanter
- **CE SAIN:** Living Fence, Permaculture, Vermicompost
- **Unlocking the production potential of polder communities in Bangladesh:** Resilient cropping patterns for the polder ecosystem

#### Technologies Transferred:

- **ASMC:** Small to Medium Combine Rice Harvester
- **WAgN:** Green manure cover and relay cropping after rice, Tomatoes grafted onto eggplant rootstock, Wild Gardens

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

An annual environmental mitigation activity review was conducted by the SIIL management entity across all subawards. The review entailed an evaluation of all activities outlined in the EMMP. Given the previous year's focus providing subawardees' with greater knowledge and tools to improve EMMP compliance and reporting, there were no issues to highlight during this reporting period. Mitigation and monitoring activities took place in accordance with the EMMP. In cases of fertilizer and pesticide purchase and use, project partners provided appropriate personal protective equipment and training for the safe use of the materials. The SIIL ME conducted a site visit to Ethiopia and verified that safety guidelines, training, and signage were addressed in accordance to the concerns raised in the previous year.

In addition, the Piestar DPx system, which the SIIL utilizes for reporting and project monitoring, underwent significant revisions of the EMMP module to support SIIL's compliance enforcement. The Piestar DPx updates included a new fertilizer, pesticide, and microbial inoculant purchase request/approval system. The annual environmental mitigation activity review also is incorporated into the DPx system to ensure that project monitoring is streamlined and to optimize knowledge sharing within the SIIL management entity. The current EMMP module is shown below. Categories not shown in the screen shot include: a) conducting applied research not exceeding 4 ha in a single location and NOT involving support for procurement or use of chemicals pesticides or fertilizers; b) conducting research not exceeding 4 ha in a single location that DOES involve the procurement and use of use of chemicals pesticides or fertilizers; c) conducting applied research exceeding 4 ha in a single location; d) conducting applied research with microbial inoculants. Responses from investigators are reviewed semi-annually by the SIIL management entity to ensure compliance with the SIIL EMMP. All sub-award activities are currently in compliance with the SIIL EMMP.



## X. Open Data Management Plan

The SIIL management entity established the SIIL Dataverse to store and curate all SIIL subaward datasets and serve as a data repository and access hub for the SI community in general. During this reporting period, SIIL subawards and consortia reported that 39 separate complete datasets have been uploaded representing 219 files. The complete datasets can be found in the SIIL's Dataverse (<https://dataverse.harvard.edu/dataverse/SIIL>), hosted by Harvard Dataverse.

Each complete dataset are required to, at a minimum, include: codebooks; metadata; data dictionaries; forms, templates, and data gathering tools; explanations of redactions, when applicable (e.g. anonymization, removal/redaction/masking of personally identifiable information); notes on data quality, data limitations, or data context; and data gathering methodologies, dates, points of contact, geolocation(s).

The SIIL is in continual discussions with USAID's Data Development Library (DDL) staff to resolve issues related to the Geospatial and Farming Systems Research Consortium and the Precision Agricultural project on how to submit datasets given the excessive size of these geospatial datasets.

The SIIL also has continued to utilize CGSpace as a repository for sharing informal publications and outputs from SIIL funded work. SIIL established this repository with CGSpace in 2017 to share SIIL funded outputs that otherwise did not have formal publishing platforms for public sharing. To date, 44 communications materials such as presentations, videos and other media, management documents, reports, training materials, newsletters and stories, and other communications materials have been shared on the [SIIL CGSpace](#) repository for open access.

Finally, all previous SIIL annual reports (2015-2019) have been uploaded into the [USAID Development Experience Clearinghouse \(DEC\)](#) and are available to the public.

## XI. Governance and Management Entity Information

### Regional and Country Coordinator Activity

The SIIL coordinators in Senegal, Burkina Faso, Tanzania, and Cambodia monitor in-country activities, represent various capacities, and organize SIIL-funded events. The coordinators in Burkina Faso, Senegal, and Tanzania also conduct research to address gaps or expand the scope of in existing in-country SIIL subawards. Descriptions of the research and accomplishments are below:

(1) Burkina Faso: Dr. Hamidou Traore and his team's research aims to integrate available soil, water, plant and nutrient management practices in crop rotation to enhance crop yields. Accomplishments include: a) conducted a survey on sustainable intensification in the area of implementation of ASM, carried out in Western area of the country; b) selected cowpea genotypes bred for drought, Striga-resistance, and low P/N tolerance, N fixation: the seeds of mutants M2 of 3 cowpea varieties (Tiligré, K VX 396 and Moussa Local) were sown on farmer field hired in Kamboinsé village to produce mutants M3 under irrigation; c) continued to implement a long-term trial related to soil nutrient management on the Saria Research Station (long-term data from this research will be shared with SIIL to produce a co-authored publication): Long-term trial is carried out and targeted data are been collected; d) inventoried weeds in long-term trial on the Saria Research Station (Farako-Ba & Kamboinsé, and; e) implemented a long-term trial related to soil nutrient management on the Saria Research Station (long term data from this research will be shared with SIIL to produce a co-authored publication.

(2) Cambodia: Dr. Manny Reyes continues his work as the SIIL Country Coordinator for SIIL, working primarily with CE SAIN and the ASMC-Cambodia teams, but also continuing SIIL's regional work in South Asia by cultivation partnerships in the Philippines, Bangladesh, and other countries in the area. Here are a few of the highlighted accomplishments from FY 2020: a) signed a memorandum of understanding (MOU) between SEARCA and KSU, to scale-up the successful school/home garden project in the Philippines at one of the CE SAIN Aggie Tech parks, as well as two high schools, in collaboration with the Royal University of Agriculture in Cambodia (RUA); b) wrote a proposal that got funded by the United Service Foundation (USF) to support four years of tuition scholarships to four high school students at RUA, with added access to computers at the CE SAIN headquarters (USF provided an extra \$2,500 to purchase computers housed at the CE SAIN headquarters); c) an unassembled Oggun 2 tractor was purchased and shipped to Cambodia for an open systems machinery workshop January 8-9, 2020; d) organized and hosted the sixth international SWAT Southeast Asian workshop and conference held in Cambodia, October 21 to 26, 2019.

(3) Senegal: Dr. Aliou Faye and his team have continued to work in Senegal, as well as network with other partner organization in the West Africa region. Accomplishments include: a) working with CORAF and iREACH on the implementation of the technology park, to be house at CERAAS, including drafting the technology park protocol and helping to identify the potential list of technologies to be housed and displayed at the parks; b) implementing dual-purpose cowpea and millet trials with Peace Corps Master Farmers at Tawa Fall, Keur Douada Cissé and Keur Bakary Villages; c) collaborated with other partner organizations ( the Sustag project with Mathematica, the AICCRA project with ICRISAT), and; d) activities related to the funding extension for the Senegal project, co-led by Dr. Min Doohong and Dr. Zachary Stewart, both at KSU.

### SIIL Personnel Changes

SIIL hired a new International Communications Specialist, Layne Wilson, who started in March 2020 to support our communication, knowledge sharing and dissemination efforts. The link to her profile on the SIIL website can be found [here](#).

## Funding Extension Activities

Select projects that strengthen SILL's research portfolio were invited to submit a concept note informed and built on their previous research achievements, and designed to address the suitability, scalability, and sustainability of the technologies developed by their projects. Following the evaluation of the concept notes, full proposals were requested and reviewed by the SILL, the EAB and USAID and contracts finalized during this reporting period. These research projects will build on the achievements of the past four years while ensuring the continued relevance of the research and aligning with the SILL's renewed focus on supporting local responsibility and accountability. The SILL will lean towards a regional approach to enhance coordination as well as scaling and adoption of appropriate technologies, and contributions to the [U.S. Government's Global Food Security Research Strategy \(GFSRS\)](#).

## No-Cost Extension Activities

The Feed the Future Innovation Lab for Collaborative Research on Sustainable Intensification (SILL) continued to support existing subawards and consortia with no-cost extensions from March - September 2020. All subawards developed transition plans outlining their research plans that were supported and integrated with other research programs in the country or region beyond the end date of their awards. Results from these plans will be highlighted in SILL's Five-Year Report.

## SOILS Consortium Activities

The SOILS Consortium developed and awarded two research activities in Niger and Ethiopia. In Niger, the goal is to develop land-use planning maps in Niger that provides land capability classifications to guide commune and/or individual level decision making about appropriate land management. These maps will provide guidance on whether livestock, crop, fodder, rangeland, conservation or other land management practices are the most suitable to sustainably intensify smallholder systems. In Ethiopia, the objective is to improve the targeting of fertilizers (rate and source) to specific crops and areas of Ethiopia resulting in increased yield and more economic fertilizer use. Coordination and alignment of activities has been a significant component to the work plan of the SOILS Consortium. The research activities outlined above fit within a unified agenda that was developed in collaboration with lead soil fertility partners. Two partnership meetings were held to facilitate such coordination. The Niger Partners Meeting was held November 21-22, 2019 in Niamey, Niger. This meeting refined and finalized the Joint Action Plan for integrated activities in soil and land use planning in Niger as the full action plan and identified the new SOILS activities to fill gaps, which is currently being implemented. The consultation meeting with Ministry of Agriculture, Ethiopia; Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ); and Bill & Melinda Gates Foundation as part of the "Supporting Soil Health Interventions in Ethiopia: Opportunities for Accelerating Impact" meeting was held in Addis Ababa, Ethiopia on February 6-7, 2020. This meeting guided the creation of the Ethiopia Research Activities (outlined above) and coordinated these activities with EIAR (i.e., Birru), Gates (i.e., Christian Witt), GIZ (i.e., Steffen Shultz), Excellence in Agronomy Platform (i.e., Bernard Vanlauwe), and Africa RISING (i.e., Peter Thorne). The SOILS Consortium also hired the Post-Doctoral Fellow, Dr. Mulugeta Below.

## iREACH Agreement Finalization and Implementation

SILL, CORAF and USAID have signed a contract to implement the West African (i)Innovation, Research, Extension and Advisory Coordination Hub (iREACH). In addition, an iREACH program manager has been hired, and the work plan, technology park protocols, and budget are in the process of being finalized. The goal of iREACH is to contribute to improved coordination of activities funded by USAID and other key donors of CORAF and the Innovation Labs in the region – as a result, making program implementation efficient and effective. The three objectives are: 1) improve coordination, alignment and integration of relevant activities, 2) create and strengthen technology parks and facilitate effective flow of information and innovations, and 3) build human and institutional capacity.

## XII. Other Topics

### Center of Excellence on Sustainable Agricultural Intensification and Nutrition (CE SAIN) at the Royal University of Agriculture

1. **Name:** The Center of Excellence on Sustainable Agricultural Intensification and Nutrition (CE SAIN)
2. **Locations:** Phnom Penh, Cambodia
3. **Description:** CE SAIN – housed in Cambodia’s Royal University of Agriculture (RUA) – helps improve food and nutritional security in Cambodia by supporting agricultural research and education while fostering innovation. CE SAIN’s goal is to foster private sector innovation, agricultural research, education and training, and public sector capacity building through improved collaboration and knowledge sharing that is focused on improving food and nutritional security while enhancing quality of soil, water and biodiversity. CE SAIN’s three core objectives are: a) coordinate and leverage Innovation Labs and other USAID-funded SAIN activities, b) build human and institutional capacity of the RUA, and, c) establish Technology Parks to showcase high-potential technologies and strategies to sustainably intensify smallholder farming systems.
4. **Collaborators:** Cambodia - Conservation Agriculture Service Center (CASC); Ministry of Agriculture Forestry and Fisheries (MAFF); Ministry of Education, Youth, and Sport (MoEY); Department of Agricultural Engineering (DAEng); Royal University of Agriculture - Phnom Penh; University of Battambang; and multiple Feed the Future Innovation Labs (e.g. Horticulture; Livestock Systems; Integrated Pest Management); and Swisscontact. Additional collaborators due to the ASA CAST (Commercialization of Aquaculture for Sustainable Trade) project include American Soybean Association, World Vision, and Auburn University.
5. **Key Achievements (See FY 2020 Annual Work Plan Activity 4.1):**
  - CE SAIN’s *Youth in Agriculture Program (YAP)*: Through the ongoing collaboration with two high schools and a technical and vocational training program of Chea Sim University of Kamchaymear (CSUK), 202 students (102 females) engaged with our YAP. CE SAIN Farm Managers together with agriculture teachers of the respective host institutions provide mentoring support to the students in agricultural technologies and practices showcased in the school garden/CE SAIN’s ATPs. It was observed that the students really enjoy learning and practicing agricultural technologies and practices, especially during the harvest and the school gardening competition program. However, activities were scaled down in April due to COVID-19.
  - In November 2019, CE SAIN in partnership with University of Tennessee (UT) was awarded from USAID Farmer-to-Farmer (F2F) Program on a new project entitled “Cambodia Sustainable Intensification Farmer to Farmer Program” for the duration of three years (2020-2023). This project is targeting Battambang, Siem Reap and other provinces, which is driven by the scope of work of the local host institutions. Currently, there are some potential organizations which F2F is working with them in the Host Recruitment Process such as 4 NGOs (CFAP, AFD, HEKS, Harvest II) two governmental agencies such as Polytechnic Institute in Kampong Thom, and University of Battambang.
  - CE SAIN in partnership with ASA/CAST hosted the launch of Aquaculture Research and Demonstration Ponds at RUA with about 70 participants with the present of the U.S. ambassador and Minister of MAFF and other delegates. In addition, two farmer field days were conducted at RUA, one held in August 2020 and another one held in September 2020 with 120 participants in total.
  - 797.8 of hectares of land improved (144 ha of land levelling (106 ha in the lowland and 38 ha in the upland), 235 ha of rice sowing with NTP, 41.5 ha of cover crop establishment as bio-pump, 359.3 ha of corn sowing with NTP, 37 ha of cassava planter with no-till cassava planter, 8 ha of pasture and living cover crops, 10 ha of cover crops seed production).

## 6. **Capacity Building:**

- 14 CE SAIN staff members (6 females) joined the trainings/workshops with NGO partners and stakeholders to strengthen and improve their capacity for their career development and encourage the learning and knowledge sharing platform within staff and partners.
- 1,706 individuals (719 females, 42%) visited all CE SAIN's ATPs. The groups represented farmers, academics, NGOs, youth groups, USG partners, Innovation Lab teams, business owners, researchers, and high-ranking officials (Secretary of State of Ministry of Education, Youth and Sport and the U.S. Ambassador).
- The first service provider, Mr. Chhroeng Ky (Sangha village, Rattanak Mondoul), who invested in a no-till planter for maize generating profit in Year 1 (2018/2019), continues to serve his community and promotes the use of cover crops to a larger network being also a seed producer. He was once again active this year by offering services for maize sowing (2020: 97 ha, 10 households; 2019: 112 ha).
- CE SAIN continued facilitating the activities of research projects funded by CE SAIN. They produced findings and finalized their final year of the project implementation. CE SAIN produced a case study to represent the Research and Innovation Program.
- There were 19 trainings conducted by CE SAIN and CASF with 646 (218F 34%) participants including farmers, private sectors, government agencies students, professors, researchers, NGO partners, development workers and others.

## 7. **Lessons Learned:**

- Due to COVID-19, the local government has been strictly monitoring gatherings, and universities and high schools were shut down, so activities with students were postponed. Therefore, CE SAIN decided to delay some activities from February 2020 and instructed staff to work from home. ATPs scaled down activities as many as possible to minimize the engagement of people in the ATPs.
- There are two big challenges on the supply side of the transition toward CA/Sl in Cambodia. First is the importation process of the no-planters. It was proven difficult and costly to import from Brazil. The second challenge was the price of the Brazil no-till planters. It is without a doubt a good quality no-till planter, but with costly importing fees plus its original price, the planter cost exceeds ten thousand US dollars. There is a need to identify potential no-planters in other countries that are less expensive and have a bilateral trade agreement with Cambodia. Hopefully, this will reduce the complicated importing process and the costly import price.
- A team comprised of two staff members until April 2020 conducted activities in 3 districts and 15 villages (9 villages in the uplands of Rattanak Mondoul and 6 villages in the lowlands of Banan). Due to the load of activity, a junior agronomist was recruited in April 2020 to facilitate the field supervision and technical support to farmers. There is still a bottleneck related to the purchase of no-till planters by service providers. This issue needs to be addressed as soon as possible otherwise the scaling-up process will not occur and the establishment of pilot on-farm demonstrations through the CASI extension model will not provide expected results.

## 8. **Presentations and Publications:**

- Hin L, Buntong B, Reyes MR, Hok L. (2020). Effects of crimping by Oggun tractor-mounted roller/crimper on cover crop termination, soil strength, and soil moisture in upland Cambodia. International Journal of Environmental and Rural Development (IJERD). [http://www.iserd.net/?page\\_id=1406](http://www.iserd.net/?page_id=1406)
- Hin L, Buntong B, Reyes MR, Hok L, Lor L, Tivet F, Leng V, Suos V, Clemmons H, Kornecki TS. (2020). Effects of different management methods for Sunn-hemp cover crop on corn production in a no-till system in Cambodia. American Society of Agricultural and Biological Engineers (ASABE).

<https://elibrary.asabe.org/azdez.asp?JID=5&AID=51453&Abstract=2000579.htm&CID=virt2020&T=3>

- Nut N, Joeng J, Worqlul A, Reyes MR, Chan S, Kieu NL, Oeurng C, Chhuon K, Doro L, Srinivasan R. (2020). Assessment of impacts of land use and climate change on streamflow and soil erosion in the Stung Chinit Catchment, Cambodia using APEX model. Presented in American Society of Agricultural and Biological Engineers (ASABE)
- Nut N, Mihara M, Chan S, Reyes MR, Sigua GC. (2020). Application of APEX model in evaluating streamflow and sediment yield in Stung Chinit catchment. International Journal of Environmental and Rural Development (IJERD).
- Nut N, Mihara M, Chan S, Sigua GC, Reyes MR, Sourn T. (2020). Impacts of land use/land cover change on streamflow and water balance of Stung Sangker catchment using SWAT. International Journal of Environmental and Rural Development (IJERD).
- Nut N, Reyes MR, Sigua GC, Doro L, Worqlul A, Jeong J, Srinivasan R, Kieu NL, Ly S, Tivet F, Leng V, Lor L, Chan S, Suos V. (2019). Evaluation of soil carbon sequestration in conservation agriculture production and conventional tillage systems in Cambodia using APEX. 2019 International SWAT-SEA Conference, Siem Reap, Cambodia.



## Gender Integration Highlights:

During the FY 2020 reporting period, SILL requested the Consortia and subwardees to provide additional information on how their projects were integrating gender into their research. All of them are actively integrated gender into their programs. While many projects reported implementation issues due to COVID-19, below are the highlights from few selected projects:

The ASMC team at MSU, including Tillers International, traveled to Burkina Faso and held a group meeting with farmers to assess their impressions of the project and to also assess gender issues. Farmers were highly receptive to adoption of new technologies that would reduce labor especially among women and make them productive. The ASMC planter was well received.

The Polder project in Bangladesh provided training to 91 women farmers and women leaders in the southwest region on fertilizer and pest management in HYV rice, rabi crops cultivation on moist soil and management practices for higher yield and income, and importance of zinc-enriched rice, maize, mungbean and sunflower on household nutrition, especially on children and lactating women.

The ASMC presented at the ECHO Annual Conference in Fort Myers Florida November 13, 2019. Two-hour Conference workshop on ‘Assessing Technologies for Gender Sensitivity’ attended by 22 participants. Additionally, the workshop acted as a springboard to test a revised framework for the training module.

A document was written to be made into a short 15-minute video for television, which will be used to show ASMC’s work in Burkina Faso and the main outcomes where gender is the main focus.

## Nutrition Integration Highlights:

During the FY 2020 reporting period, SILL also requested the Consortia and subwardees to provide additional information on how their projects were addressing nutrition as a cross-cutting theme into their research activities. While many projects reported implementation issues due to COVID-19, below are the highlights from few selected projects:

A key accomplishment of WAgN was the characterization of the potential wild food plant nutritional impact on small farms. During this reporting period, activities included development of a nursery network focused on wild food plant propagation and distribution. One Battambang nursery is producing over 500 Acacia pennate, which will become a key component of wild gardens in the S3 Green Labs.

Policy Research Consortium partner, Dr. Will Masters, and colleagues, will continue their work on developing an indicator to measure the market cost of nutritious diets. Such an indicator is needed as households rely on markets to fill food needs, markets and changing and existing markets are changing rapidly, including in response to the policy. As a result, a nutrient-adequate diet is out of reach for many people and targeted action is needed to lower and stabilize prices of nutrient-rich foods and nutritious diets.

The ASMIH-Ethiopia hub conducted research on "Adoption & Contribution Of Post-Harvest Storage Technology For Women Farmers: The Case Of Dengeshita And Kudmi Kebele In Dangila Woreda And Merawi Town Amhara National Regional State, Ethiopia” with the help of an MA student and the final report was submitted to ASMC.

## XIII. Issues

### COVID-19

For the first part of the reporting period, SIIL did not encounter any serious issues. However, as the COVID-19 pandemic issues emerged and expanded to global proportions, projects have slowed or postponed research activities, fieldwork, training and other capacity-building activities in most of our focus countries, as all travel has either been cancelled or been limited to essential travel only. Several of our subawards had prior no-cost extensions, but needed extra time beyond the original extension periods, which was granted. Issues included projects reporting a loss of the growing season as a result of the pandemic, the inability to meet in person to conduct trainings and the inability to meet with other collaborators.

## XIV. Future Directions and Activities

### Implementing Extended Projects and Consortia

Through a rigorous review process the SIIL extended projects with the intent that the projects would be informed and built on their previous research achievements, and designed to address the suitability, scalability, and sustainability of the technologies developed by their projects. All projects activities focus on the resilience of smallholder farmer will be funded for three years (July 2020 to June 2023). The following awards began limited implementation late in the fourth quarter and will be at full capacity in FY 2021. The specific projects are listed below along with the lead Principal Investigators and institutions:

- Led by Drs. Krishna Jagadish and Sudhir Yadav, *Pathways of Scaling Agricultural Innovations for Sustainable Intensification in the Polders of Coastal Bangladesh* (KSU and International Rice Research Institute)
- Led by Drs. Doohong Min and Aliou Faye, *Improving Food and Nutrition Security of Smallholder Agro-pastoral Farming Systems by Integrating Crop-livestock-human Nutrition in Senegal and Niger* (KSU and Senegalese Institute for Agricultural Research)
- Led by Dr. Dave Ader, *S3-Cambodia: Scaling Suitable Sustainable Technologies* (University of Tennessee)
- Led by Dr. Prasanta Kalita, *Appropriate Scale Mechanization Consortium for Sustainable Intensification* (University of Illinois at Urbana-Champaign)
- Led by Dr. Ignacio Ciampitti, *Digital and Geospatial Tools Consortium—Building a New Era of Predictive Agricultural Innovation to Improve the Livelihood of Smallholder Farmers* (KSU)
- Led by Dr. Carl Pray, *Policy Research Consortium* (Rutgers University)

The SIIL will continue to work towards a regional approach to enhance coordination as well as scaling and adoption of appropriate technologies, and contributions to the [U.S. Government's Global Food Security Research Strategy \(GFSRS\)](#)

### Evaluating System Productivity, Synergies and Tradeoffs

All projects use the SI Assessment Framework to evaluate their technologies and look at the synergies and tradeoffs. SIIL will continue these efforts and encourage researchers and implementing partners to look into further details to quantify overall systems productivity by putting all the components of the research or package of practices. In addition, projects evaluated synergies and tradeoffs at the landscape, farm and/or household scale rather than at individual plot levels with their innovations.

### Mobile Application and Video for the SI Assessment Framework

The Sustainable Intensification (SI) Assessment Framework web tool was developed at the beginning of FY 2018. The purpose of the web tool is to facilitate greater access and usability of the framework for the SI research community. In order to increase access and usage, Dr. Zach Stewart created a training video that will be uploaded to the SIIL website for public usage. Additionally, a mobile application is currently in the works and should be available to the public by the end of 2020.

## Appendices

### Appendix A – List of Awards Given to U.S. Universities

#### Funding for Phase II: 2020 – 2024

**Title:** Appropriate Scale Mechanization Consortium

**Awarded institution:** University of Illinois at Urbana-Champaign

**Dates:** July 1, 2020 - June 30, 2023

**Current year funding:** \$749,997

**Total funding:** \$2,249,991

**Title:** Digital and Geospatial Tools Consortium

**Awarded institution:** Kansas State University

**Dates:** July 1, 2020 - June 30, 2023

**Current year funding:** \$500,000

**Total funding:** \$3,000,000

**Title:** Innovation Research, Extension and Advisory Coordination Hub (iREACH)

**Awarded institution:** West and Central Africa Council of Agricultural Research and Development (CORAF)

**Dates:** April 1, 2020 - March 31, 2022

**Current year funding:** \$61,330

**Total funding:** \$249,000

**Title:** Unlocking the Production Potential of “Polder Communities” in Coastal Bangladesh through Improved Resource Use Efficiency and Diversified Cropping Systems

**Awarded institution:** Kansas State University

**Dates:** July 1, 2020 - June 30, 2023

**Current year funding:** \$254,764

**Total funding:** \$749,999

**Title:** Scaling Dual-Purpose Pearl Millet-Based Technologies for the Resilience of Small-Holder Farmers in Senegal and Niger

**Awarded institution:** Kansas State University

**Dates:** July 1, 2020 - June 30, 2023

**Current year funding:** \$138,528

**Total funding:** \$749,999

**Title:** S3 Cambodia: Scaling Suitable Sustainable Technologies

**Awarded institution:** University of Tennessee

**Dates:** July 1, 2020 - June 30, 2023

**Current year funding:** \$260,115

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

**Title:** Feed the Future Policy Impacts Study Associate Award (Policy Research Consortium)

**Awarded institution:** Rutgers University

**Award Date:** August 8, 2018 – December 6, 2021

**Current year funding:** \$725,000

**Total funding:** \$3,900,000

**Funding for Phase I: 2014 - 2020**

**Title:** Geospatial and Farming Systems Research Consortium

**Awarded institution:** University of California, Davis

**Dates:** September 16, 2014 - March 31, 2020

**Current year funding:** \$0

**Total funding:** \$4,185,524

**Title:** Appropriate Scale Mechanization Consortium

**Awarded institution:** University of Illinois at Urbana-Champaign

**Dates:** October 1, 2015 - September 30, 2020

**Current year funding:** \$0

**Total funding:** \$4,700,000

**Title:** Unlocking the Production Potential of “Polder Communities” in Coastal Bangladesh through Improved Resource Use Efficiency and Diversified Cropping Systems

**Awarded institution:** Kansas State University

**Dates:** October 1, 2015 - June 30, 2020

**Current year funding:** \$0

**Total funding:** \$987,829

**Title:** Adoption of Sustainable Intensification in Dual-Purpose Millet - Leguminous Crops – Livestock Systems to Improve Food and Nutritional Security and Natural Resources Management for Rural Small Holder Farmers in Senegal

**Awarded institution:** Kansas State University

**Dates:** October 1, 2015 -September 30, 2020

**Current year funding:** \$0

**Total funding:** \$966,102

**Title:** Raising Crop Response: Bidirectional Learning to Catalyze Sustainable Intensification at Multiple Scales

**Awarded institution:** Michigan State University

**Dates:** October 1, 2015 - June 30, 2020

**Current year funding:** \$0

**Total funding:** \$996,764

**Title:** Women in Agriculture Network (WAgN) Cambodia: Gender- and Ecologically – Sensitive Agriculture

**Awarded institution:** Pennsylvania State University

**Dates:** October 1, 2015 -September 30, 2020

**Current year funding:** \$0

**Total funding:** \$1,000,000

**Title:** Evaluation of the Relationship between Sustainably Intensified Production Systems and Nutritional Outcomes (SIPSIN)

**Awarded institution:** Texas A&M University

**Dates:** October 1, 2015 -September 15, 2019

**Current year funding:** \$0

**Total funding:** \$999,198

**Title:** Developing Indicators for Sustainable Intensification

**Awarded institution:** Columbia University

**Dates:** September 1, 2015- January 31, 2017

**Current year funding:** \$0

**Total funding:** \$237,454

**Title:** Developing Indicators for Sustainable Intensification

**Awarded institution:** University of Florida

**Dates:** February 1, 2017- November 30, 2017

**Current year funding:** \$0

**Total funding:** \$185,622

**Title:** Developing Indicators for Sustainable Intensification

**Awarded institution:** Michigan State University

**Dates:** July 1, 2015 – November 30, 2017

**Current year funding:** \$0

**Total funding:** \$374,548

**Title:** Precision Agriculture for Smallholder Systems in Africa

**Awarded institution:** Michigan State University

**Dates:** March 15, 2017 – August 31, 2019

**Current year funding:** \$0

**Total funding:** \$507,990

**Title:** Research Dissemination Output Study (RODS)

**Awarded institution:** University of California at Davis

**Dates:** February 1, 2018 – January 31, 2020

**Current year funding:** \$0

**Total funding:** \$499,409



## Appendix B – Success Stories

# SUCCESS STORIES

## Success Story #1: Woman Farmer Fighting for a Better Future

In the Anlong Ta Mei village in Cambodia, it has been difficult for women farmers to successfully grow crops and make a decent profit to provide for their families. Traditionally, women do not attend school and, instead, they spend their days toiling in their gardens to make ends meet. However, when the Feed the Future Innovation Lab for Collaborative Research on Sustainable Intensification (SIIL), through the Women in Agriculture Network (WAgN) project, initiated work in this village, those same women farmers began to encounter success by implementing sustainable agricultural techniques on their farmland.

Dani Mert is a 41-year-old woman and farmer with a husband and two children. Dani leads the local Women’s Farmer Network in the village, where she shares her experience with other farmers both in her village and in the surrounding villages as well. Dani is very dedicated to the group and enjoys helping teach other female farmers about techniques she has learned to increase her garden’s production and improve her livelihood.

By implementing sustainable agricultural techniques such as trellising, Dani has improved her production of crops, which has provided her with higher profits and the ability to expand her business. Trellising is a technique used to grow crops by keeping them off the ground, increasing usable space, which, in turn, increases the yield produced. This technique is an example of a simple, low-cost investment that Dani made, which then allowed her to intercrop multiple vegetables such as beans, squash, and peppers all in the same row. Because of this, Dani has more than doubled her income, and has gone from producing just one cycle of crops each year, to producing at least three cycles a year!

The resources she has received from the WAgN project are helping Dani, along with other female farmers in Cambodia, to realize the value that sustainable agricultural techniques have in benefiting her family and the land. These new practices, however, do not come without challenges. In one planting cycle, just before harvest time, the trellises that Dani had built collapsed due to high winds. After all her hard work, Dani was understandably devastated about what happened. “When the trellises fell down, I felt so sad because I hoped I would get a good yield back after I spent a long time growing the crop. I lost a lot of money.” However, firm in the determination to grow her business and become an empowered female farmer, she pushed through the season using the skills



*Dani is shown in one of her plots of vegetables. Dani has incorporated mulching, raised beds and a tank for drip irrigation that all help increase her production.*

she had learned. “I will not give up growing. I will still continue with growing vegetables for my business. If I have some problem, like my trellis falling down, I will try to find a solution.”

Now, after three years of training and partnership with Feed the Future and WAgN, Dani is not only successfully producing vegetables on her farm but additionally, her daughter, Leakhena, is now studying to earn a bachelor’s degree in horticulture after witnessing her mom’s success! Dani is excited to show the continued work of sustainable agricultural practices she implements because of the help and support of the SIIL.



*Dani standing next to the fallen trellis with the technician, Channaty Ngang.*

There are times when it can be hard to see the tangible impact an intervention has made in a person’s life - it is not always measurable and can manifest itself in unexpected ways and at unexpected times. Dani, however, has proven through her successful farm in Cambodia, that an inspiring, positive impact has been made in her life, and that, through her, women farmers can become more empowered and are taking steps to end poverty.



## Success Story #2: Minister of Agriculture, other prominent guests present at ASMC Bangladesh Workshop

On Sept. 23, the Feed the Future Innovation Lab for Collaborative Research on Sustainable Intensification (SIIL) hosted the Appropriate Scale Mechanization Consortium (ASMC) annual workshop. Because of the ongoing COVID-19 pandemic, the workshop was held virtually. Kansas State University (KSU), ASMC, based at the University of Illinois at Urbana-Champaign (U of I), and Bangladesh Agricultural University in Bangladesh partnered to organize the annual workshop, “Appropriate Agricultural Machinery: A Key to Sustainable Food Security in Bangladesh.”

KSU, U of I and Bangladesh Agricultural University have jointly implemented the Appropriate Scale Mechanization Innovation Hub (ASMIH)-Bangladesh research project through the SIIL and funded by the United States Agency for International Development (USAID).



Farmers harvesting with a reaper during the COVID-19 season in Wazirpur, Barishal, Bangladesh. May 2020.

The Chief guest was Muhammad Abdur Razzaque, MP, Honorable Minister, Ministry of Agriculture, Government of the People’s Republic of Bangladesh. Razzaque is one of the forefront visionary leaders of smart agriculture and agricultural mechanization for sustainable food security in Bangladesh. Other speakers of the inaugural session of the workshop included Lutful Hassan, Vice Chancellor of Bangladesh Agricultural University as the Chief Patron, P.V. Vara Prasad, Director of the SIIL at KSU, as the Special Guest and Prasanta Kalita, Director of ASMC at UIUC, as the session Chair.

Razzaque stressed the necessity of agriculture machinery to aid in harvest. This is because of a variety factors — including, though not limited to, increases in production cost, geographical effects on crop yields and labor crises. “Our government is emphasizing on mechanization,” Razzaque said. “We have been giving incentives to farmers for adapting agricultural machines, which will help them to increase production, to move from traditional agriculture to modern agriculture.”

Prasad said the Bangladesh government has great potential for leadership in multiple areas of agricultural science and technology. Particularly, he said, they have potential in the areas of natural resource management, adaptation to climate change, diversification and mechanization.

“There are several Government programs targeted directly toward the welfare of farmers,” Prasad said. “This is commendable and noteworthy as this speaks directly to the leadership and commitment of the honorable Minister of Agriculture and the Government of Bangladesh. Strong and sustained support from the Government and private sector is key to success for agricultural programs.”

The inaugural session was followed by a discussion of the main theme of the workshop, “Appropriate Scale Mechanization: A Key to Sustainable Food Security in Bangladesh.” This session involved several distinguished panelists from Bangladesh.

“It is fantastic to see a collaboration like this for the ASMIH-Bangladesh project,” Kalita said. “And it only happens because of people who care about our farmers, food sufficiency and nutrition for the people who are working every day — who don’t have enough food to eat.”

## Success Story #3: "Now we can breathe." The Impact of a Mechanical Maize Planter on Smallholder Women Farmers in Burkina Faso

### Introduction

May 18, 2020

Burkina Faso ranks 183 on the Human Development Index, with 67% of the working population making less than \$3.10 a day (UNDP 2018). Ninety percent of the poor live in rural areas, and over 80% of the labor force is employed in the agriculture sector. The level of on-farm mechanization is low in Burkina Faso, with 70% of smallholder farmers relying on hand labor, less than 30% using draft animals, and less than two percent using tractor power. Mechanized power units are often solely used for plowing, while the other labor-intensive work of planting, weeding, crop care and harvest is by hand. Labor is increasingly scarce, yet many farmers are neither aware of alternative cropping methods, nor do they have affordable access to labor-saving mechanization. The Appropriate Scale Mechanization Consortium (ASMC) Burkina Faso Innovation Hub (IH), led by researchers at Nazi Boni University, developed appropriate mechanization technologies to benefit subsistence farmers in Burkina Faso. The IH included local and U.S. based entities working in collaboration with smallholder farmers to improve their quality of life while developing mechanization to advance the farming system and sustain the natural resource base.



*Maize planting and weeding are tedious and labor-intensive tasks primarily done by women and children.*

At the outset of the project, the IH conducted a stakeholder needs assessment to determine the agricultural tasks that could most benefit from improved mechanization in collaboration with government representatives, NGOs, farmers, service providers, and other stakeholders. In the assessment, land preparation, planting, and weed control - tasks accounting for most drudgery and labor, and primarily done by women and children - emerged as the top priorities for mechanization. Additionally, the stakeholder needs assessment identified a crosscutting need for improved, affordable tools for animal traction and conservation agriculture.

### **The burden of female farmers**

In Burkina Faso, women are typically responsible for planting among other farming tasks such as weeding, harvesting, and post-harvest activities. These tasks are in addition to other household tasks such as collecting water, child-care, cooking, and fetching firewood, which could take up to 16 hours a day. While male farmers assist with planting, the task of planting is predominantly a role for women and young girls.





Women hand-plant maize using a 'daba', a short-handled hand hoe.

Women hand plant maize by using a short-handled hoe known as a 'daba' by bending over and placing two seeds every 16 inches (two seeds per pocket assure the successful germination of at least one plant resulting in few skips within the row). Many female farmers reported back pain from the hours of stooped labor. In addition to being labor-intensive, hand planting is also time intensive. Women explained that their roles in maize planting made it challenging to get to the weekly village market and conflicted with women's individual entrepreneurial efforts in harvesting shea and cashew nuts, and planting on their separate plots of land. They also mentioned the need for a rest period to recover from the exhaustion of planting further reduced the time available for attending to other household activities.

The challenges of hand planting are exacerbated by the need for concentrated labor during short and sporadic rainy seasons when planting time is limited. In addition to finding and managing a planting crew of 15-20 people, women are responsible for providing meals to the crew, increasing the overall workload. Female farmers also mentioned that the work of the crew was often poor quality with inconsistent seed spacing and variable seed depth – both of which affected plant population and yield

potential. Planting crews' cost, on average, 1,000 CFA per day per person (about 1.75 USD per person or 35 USD for the crew per day) with the crew planting one hectare in a day. Women also spoke of the conflicts that arose in the household with expectations to both be in the field to manage the planting crew and have meals ready on time.

### **Cropping system mechanization**

In collaboration with local farmers, the team used a cropping system approach to develop an improved planter, an in-line ripper for seedbed tillage, and an improved ox yoke for animal comfort. In the development of the planter, the team used a process of adaptive management in evaluating a diverse set of technologies with varying levels of complexity compatible with the local economic, social, and environmental conditions. In the case of the planter, the IH redesigned the locally available row-crop cultivator to retain protective crop residue and reduce soil erosion. These advances in mechanization ensured that the planter and other technologies improved local farming systems by balancing higher productivity and environmental sustainability.

The team also addressed reasons for potential technology failure, which included high cost, poor performance, and lack of timely availability by building the capacity of local fabricators. In the redesign and fabrication of the planter, in-line ripper, and weeder, local blacksmiths skills and abilities to design, build, evaluate, and repair tools and equipment increased. Building the capacity of the local blacksmiths also ensured the sustainability of the planter beyond the project lifetime and guaranteed that farmers had local access to skilled labor for planter repair and maintenance. Furthermore, this process helped reduce the material cost for the planter by more than 50%.



Specific redesign features of the ASMC planter include a low-cost seed plate drive mechanism, a furrow opener suitable for minimally tilled soil and uniform depth of seed placement, and a furrow closer/press-wheel system suited for low-disturbance, soil stabilizing zone tillage. These features enabled the seeds to be placed at a uniform depth and spacing, which ensured that seeds germinated faster and at a consistent rate. Experiments in farmer's fields showed that using the planter increased maize grain yield by 50 - 150% compared to hand planting. Farmers who tested the ASMC planter with their maize crop for one to two years also mentioned that birds did not consume the planted seeds because they could not find them! Using the planter had the added advantage of reducing the need to plant twice – which was often required when planting by hand because of a low germination efficacy. Additionally, it enabled farmers to plant early before the rains.

### **Enabling women to access planters**

The ASMC IH worked with female farmers to ensure that women benefitted from the technologies through engagement in demonstrations, training, and on-farm assistance. The IH provided a one-day demonstration/training session for the first cohort of five farm families in 2018, and a second half-day session for the 2019 cohort of 20 farm families before the planting season. The IH also provided on-farm assistance to all the families. Additionally, a gender technology assessment I was conducted on the planter to understand gender dynamics that could impact adoption.

At a debriefing session with 25 farm families, women cited the time and labor-saving impact of the ASMC planter on their lives. A female farmer reported that with a family of three and a team of oxen, she could accomplish the work of a hand planting crew of 15-20. Ms. Kay Moussokoura, a farmer near Bobo-Dioulasso, said, "Here, women and children do the planting. I worked with the planter, and it was very easy to use. With the planter, it is much faster." The women used the time saved to accomplish domestic tasks such as cooking, fetching water, child-care, and going to the market. They also used the time for the income-generating activities of gathering and processing shea or cashew nuts. Female farmers using the planter also reported having more time to tend their land—income from their land and enterprises funded children's schooling, food, and clothing. Women also saved the money from their enterprises for unexpected expenses such as medical care and other family expenses.

The ASMC planter also affected intra-household dynamics by making planting a household task rather than a woman-only task. Many women farmers preferred not to handle oxen, considering it too dangerous. This unease with handling oxen echoes findings of the gender technology assessment, which identified access and use of oxen to operate the planter as a gender barrier. In the eight households represented at the November debriefing session, farmers overcame this barrier with women operating the planter and men (household or hired) handling the oxen. Women also reported difficulty in turning the planter at the end of the cropping rows and suggested lowering the height of the planter's handles. Other suggestions made by female farmers included modifications to enable planting of other crops (ranked by importance after maize) cowpeas, groundnuts, soybean, and sorghum. Women were also very interested in better tools for land preparation and weeding. The ASMC team has modified



*Local artisans learned to build and repair planters and in-line subsoilers using locally available materials.*

the final prototype for scaling up to include height-adjustable handles. ASMC Phase II will create an alternative planter prototype that uses donkey draft power to improve gender accessibility for women farmers.

### **Advancing farm mechanization advances gender equity**

The ASMC planter has design, process, and gendered benefits for subsistence farmers in Burkina Faso. Design benefits include efficient and effective planting (improved grain yield); process benefits include accessibility, affordability and reparability, and gender benefits of time and labor-saving for women farmers. The planter's benefits were enabled by linking the innovation to social processes, and by using a participatory approach involving farmers (male and female), educators, and local fabricators.



*Processing cashew nuts. Use of the planter saved time which was re-employed in income generating activities and invested back into the household.*

The development of the ASMC planter has shown that it is essential to evaluate mechanized innovations both in technical terms and within social, cultural, and economic contexts. Specifically, it is crucial to consider agricultural mechanization and technologies through a gender lens to ensure that they reach, benefit, and, when possible – empower female smallholder farmers. In the case of the ASMC planter, women save time and labor, which is re-employed toward domestic and income-generating activities - which are ultimately invested back into the household. As the women farmers exclaimed to the team, "**God will thank you for what you have done for us. Please do not forget about the women. Now we can breathe.**"