

2023

ANNUAL PERFORMANCE REPORT



Innovation Lab for Collaborative
Research on Sustainable Intensification
transforming farming systems for smallholders



Feed the Future Innovation Lab for Collaborative Research on Sustainable Intensification

Annual Performance Report FY 2023

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Cover Photos

Top Left: Cambodian students learn to propagate wild food plants at a plant nursery in Battambang, Cambodia. Photo credit: Saren Ry. August 2023.

Top Center: Farmers in Senegal next to Agriculture Technology Park funded by SIIL in Theis, Senegal. Photo credit: Aliou Faye. October 2023.

Top Right: Students harvesting Mung bean in the polders of Bangladesh. Photo credit: Mary Ann Batas. March 2023.

Bottom: SIIL partners and associates at 2023 Annual Meeting in Senegal. Photo credit: Sanders Barbee. July 2022.



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@ksu.edu

P.V. 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 the 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. 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 (Non-Governmental Organizations), local non-profits, and private industry in Cambodia.



Jessica Means – Business Manager

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Jessica Means serves as the Business Manager for the SIIL. 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 Davis – Program Administrator

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Layne Davis 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. Layne works with all of SIIL's projects, consortiums, and initiatives to provide regular updates and progress. She assists with effective outreach from project activities to showcase the Lab's successes. Layne graduated from Texas Tech University with a Bachelor of Science in Agricultural Communications and a minor in Agribusiness Management.



Sanders Williams – International Communications Officer

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Sanders Williams serves as the International Communications Officer for the SILL. In her role, Sanders helps to expand and promote communication strategies, success stories, SILL newsletters, and social media content from project activities for effective outreach. Sanders graduated from Kansas State University (KSU) with a major in Agricultural Economics, with a pre-law focus. While her time at KSU, she performed as a fellow with the K-State's Food and Agriculture Policy Fellowship, served two years as Secretary in the college MANRRS chapter, and lead as the Assistant Section Leader in the University marching band where she played the mellophone. Sanders recently served as the Conservation & Sustainability Fellow for the Kansas Grain Sorghum's Producer Association where she assisted Kansas Grain Sorghum in connecting with sustainability projects focusing on farm-oriented programming. During her time as a student, Sanders had the opportunity to travel to Morocco for an agriculturally focused cultural exchange. She is also the recipient of the 2022 George Washington Carver Leadership and Legacy Award.



Dr. Elizabeth Guertal – Program Director

Email: guertea@ksu.edu

Prior to joining the SILL team Beth Guertal was the Rowe Endowed Professor in the Crop, Soil and Environmental Sciences Department at Auburn University, AL. In 2022 she served a one-year assignment with USAID (in ITR/R) as a Jefferson Science Fellow, one of 15 such Fellows selected by the National Academies of Sciences, Engineering and Medicine. Guertal received her B.S. and M.S. degrees from The Ohio State University, and her Ph.D. from Oklahoma State University. Her research program focuses on soil fertility issues in turfgrass management. Guertal served as a Technical Editor for Crop Science, and as an Associate Editor for the Soil Science Society of America (SSSA) Journal, Crop Science (CSSA) and Agronomy Journal (ASA). She is a past-Chair of Division C-5 (Turfgrass Management, CSSA), a Fulbright Fellow and a Fellow of CSSA, SSSA, and ASA. She is a past President of the Crop Science Society of America.



LaTrese Taylor – Program Manager, Completed Service May 2023

Email: latreset@ksu.edu

LaTrese Taylor served as Program Support for the SILL at Kansas State University. LaTrese earned her B.A. in Psychology from the University of Nevada Las Vegas. She holds an M.A. and an M.S. in Human Resource Management and Organizational Management from Webster University, St Louis, and The George Washington University, Washington, DC respectfully. LaTrese was in one of the last U.S. Peace Corps Master's International (MI) cadres, combining service with a degreed program. As an MI, she served as a Peace Corps agriculture volunteer in Senegal from 2016-2019. She received an M.A. in International Development from American University, Washington DC in 2021. She brings experience in project management, monitoring/evaluation, combining research and local farmer programming, and agricultural technical training/extension in farming communities. She speaks Wolof.



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

Email: alliouselbel@gmail.com

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 (Innovation Research, Extension, and Advisory Coordination Hub) Initiative and Country Coordinator for the SIIL in Senegal.



Dr. Hamidou Traore – Country Coordinator, Burkina Faso

Email: hamitraore8@yahoo.com

Dr. Hamidou Traore has over 25 years of research experience in the field of agronomy. Dr. Traore holds a Ph.D. 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 serves as Director of the 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 – Program Manager

Email: aberhe@ksu.edu

Araya Berhe serves as Program Manager for Geospatial and Crop Model applications in the Sustainable Intensification Innovation Lab at Kansas State University. He received his Ph.D. in Production Ecology and Resources Conservation from Wageningen University, the Netherlands. Currently, his research is focused on application of crop modeling, geospatial, and agro-meteorological technique for sustainable water management, developing climate change adaptation and resilience strategies, and optimizing resources use for sustainable agricultural production and food security. In addition, his responsibilities include managing research activities related to use of crop modeling, geospatial, and digital tools for reducing impacts of water shortage, climate change and climate variability, and nutrient management related challenges in agriculture at local, regional, and global level.



Prakash Kumar Jha – Associate Scientist, Completed Service August 2023

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Prakash Kumar Jha was an associate scientist at the Kansas Agricultural Experiment Station and works in collaboration with the SILL. 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. His advisors are PV Vara Prasad and Ignacio A. Ciampitti. Prakash is currently engaged in the projects on Lonsinger Sustainability Research Farm, and the Digital Tools, Geospatial and Farming Systems Consortium (DGFSC) at Kansas State University.



Marleigh Hutchinson – Student Research Assistant

Marleigh Hutchinson serves as a Student Assistant for the SILL. She is a sophomore majoring in Environmental Engineering with a secondary major in Natural Resources and Environmental Sciences. As a student assistant, she helps create and execute laboratory communication strategies and research reports. Marleigh also serves as an undergraduate research assistant in the Carl R. Ice College of Engineering, where she works alongside faculty to develop and manage new wastewater management technologies. In addition, she is an Ambassador for the College of Engineering, is involved with Engineers Without Borders, and runs social media campaigns for the Carl and Melinda Helwig Department of Biological and Agricultural Engineering. Marleigh will graduate in May 2025.

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

Jules Pretty is Professor of Environment and Society at the University of Essex, and Director of the Centre for Public and Policy Engagement. He is formerly Deputy Vice-Chancellor (2010-19). His sole-authored books include *Sea Sagas of the North* (forthcoming, 2022), *Green Minds and a Good Life* (forthcoming, 2022), *The East Country* (2017), *The Edge of Extinction* (2014), *This Luminous Coast* (2011, 2014), *The Earth Only Endures* (2007), *Agri-Culture* (2002) and *Regenerating Agriculture* (1995).

He is a Principal Fellow of the Higher Education Academy, Fellow of the Royal Society of Biology and the Royal Society of Arts, former Deputy-Chair of the UK government's Advisory Committee on Releases to the Environment and has served on advisory committees for BBSRC (Biotechnology and Biological Sciences Research Council) and the Royal Society. He was presenter of the 1999 BBC Radio 4 series *Ploughing Eden*, a contributor and writer for the 2001 BBC TV Correspondent program *The Magic Bean*, and a panelist in 2007 for Radio 4's *The Moral Maze*. He received a 1997 award from the Indian Ecological Society, was appointed A D White Professor-at-Large by Cornell University from 2001 and is Chief & Founding Editor of the *International Journal of Agricultural Sustainability*. He received an OBE in 2006 for services to sustainable agriculture, an honorary degree from Ohio State University in 2009, and the British Science Association Presidential Medal (Agriculture and Food) in 2015. He is among the top 1% most cited scientists in the world and is host of the podcast *Louder Than Words*.



Dr. John Dixon

Australian Centre for International Agricultural Research - retired

John Dixon is Adjunct Professor focused on farming systems at the University of Queensland, Visiting Fellow on sustainable development policy at the Australian National University and Guest Professor on farming systems at Gansu Agricultural University. Dixon has 40 years developing country experience with agricultural research and sustainable development with FAO (Food and Agriculture Organization) and the CGIAR (Consultative Group of International Agricultural Research) in Asia, Africa, the Middle East, and Latin America. He has worked on many aspects of ecologically, economically, and socially sustainable intensification for food security and poverty reduction, including systems research, innovation, environment and natural resource management, systems agronomy, conservation agriculture, participatory methods, market access and value chain function, policy analysis, M&E, impact assessment, knowledge sharing. He was presented with the M S Swaminathan Award for leadership in agriculture and was elected as a Fellow of the Australian Academy of Technology Science and Engineering. The Global Evergreening Alliance has selected him as a Senior Fellow and as Chair of the Technical Advisory Board of the Restore Australia Program. Dixon is a graduate from the University of New England with a Ph.D. (agricultural economics), Masters (natural resources), Masters (economics) and Bachelor of Rural Science and has published more than 100 books, articles, chapters, and reports on the above subjects.



Dr. Cornelia Flora

Iowa State University

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 change, 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. She has published 14 books, with a 15th co-authored book in preparation. She has served as president of the Rural Sociological Society, the Agriculture, Food and Human Values Society, and the Community Development Society. Her B.A. degree is from the University of California at Berkeley and her MS and Ph.D. degrees are from Cornell University.



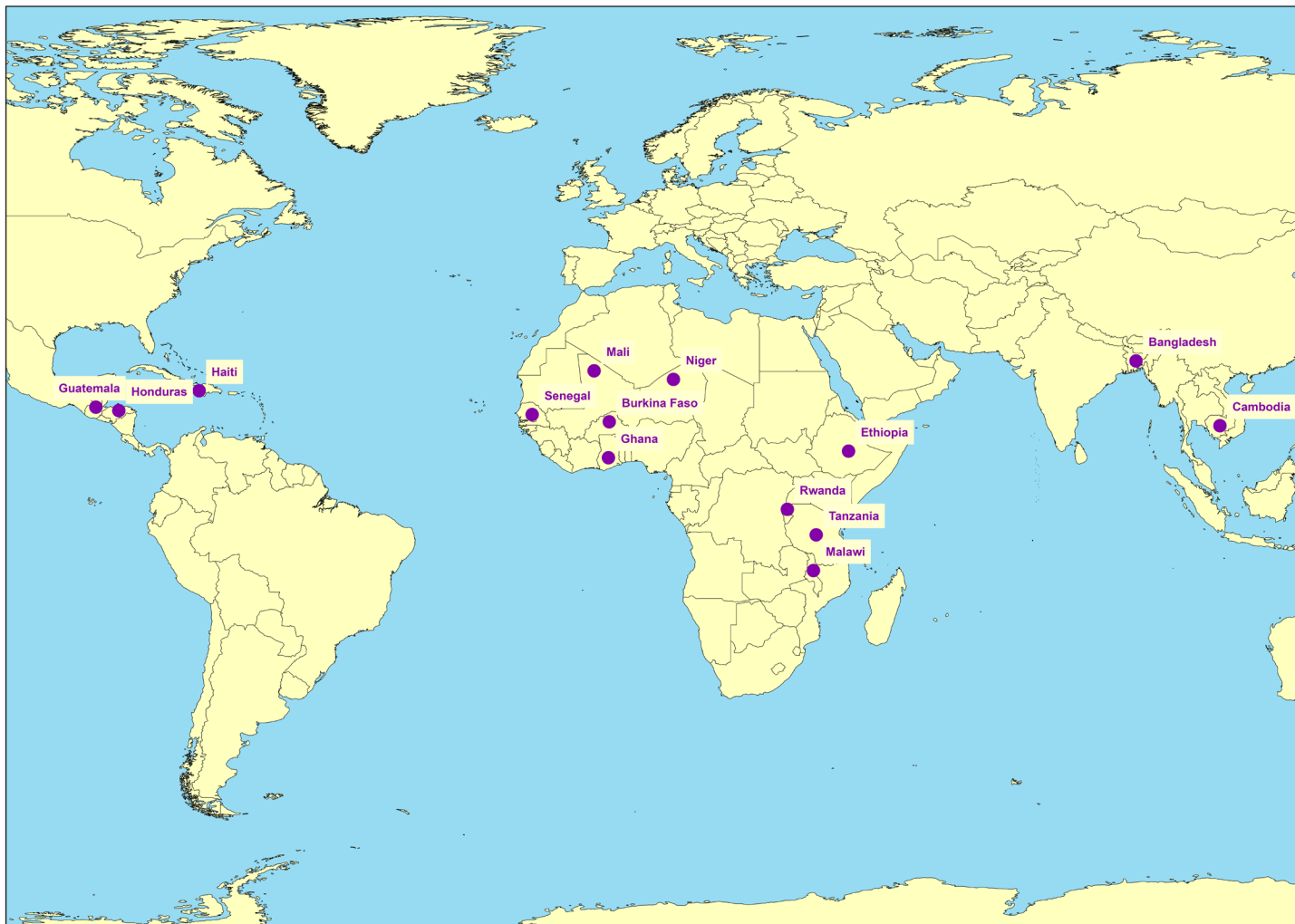
Dr. Peter Thorne

International Livestock Research Institute (ILRI) – retired

Peter Thorne coordinates the Africa RISING (Research in Sustainable Intensification for Next Generation) 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 (International Livestock Research Institute), Thorne was responsible for the national dairy benchmarking service in Britain.

Focus Countries

The Feed the Future Innovation Lab for Collaborative Research on Sustainable Intensification (SIIL) supports research in West Africa, East Africa, Asia, and Latin/Central America. This map includes all the countries that SIIL has worked in, both past and present.



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 in Africa
 Feed the Future Innovation Lab for Fish
 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
 Michigan State University
 Montana State University
 North Carolina A&T State University
 Northwestern University
 Oakland University
 Pennsylvania State University
 Rutgers University
 Stanford University
 Texas A&M University
 Tillers International
 Tufts University
 United States Peace Corps - Senegal
 University of California, Davis
 University of Colorado - Boulder
 University of Florida
 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
 Bangladesh Rice Research Institute
 BRAC
 International Maize and Wheat Improvement Center (CIMMYT)
 International Agricultural Research Center (IARC)
 International Rice Research Institute (IRRI)
 Institute of Water Modeling (IWM)
 Khulna University
 Shushilan (National NGO)

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
AVRDC – World Vegetable Center
Cambodian Agricultural Research and Development Institute (CARDI)
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)
Provincial Department of Agriculture, Forestry and Fisheries (PDAFF)
Royal University of Agriculture - Phnom Penh
SmartAgro
University of Battambang

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

Guatemala

Institute of Agricultural Science and Technology (ICTA)

Haiti

American University of the Caribbean (AUC)
Campus Henri Christophe de Limonade (CHCL)
Faculte d'Agronomie et de Medecine Veterinaire (FAMV)
Quisqueya University (UniQ)
Université Chrétienne du Nord d'Haïti (UCNH)
University Notre Dame of Haiti (UNDH)

Honduras

Directorate of Science and Agricultural Technology (DICTA)
Universidad de Zamorano

Mali

Institute of Rural Economy (IER)

Niger

National Institute of Agronomic Research (INRAN)

Senegal

Agence Nationale de Conseil Agricole et Rural (ANCAR)

Bureau d'Analyse Macro Economiques (BAME)
 Centre d'Etude pour l'Amélioration de l'Adaptation à la Sécheresse (CERAAS)
 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)
 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
 University of Western England
 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
 ADM Institute – Archer Daniels Midland Institute
 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
 ASABE – American Society of Agricultural and Biological Engineering
 ASMH – Appropriate Scale Mechanization Hub
 ASMC – Appropriate Scale Mechanization Consortium
 AUC – African Union Commission
 AUC – American University of the Caribbean
 AWP – Annual Work Plan
 BAME – Bureau d’Analyse Macro Economiques
 BARC – Bangladesh Agricultural Research Council
 BARI – Bangladesh Agricultural Research Institute
 CA – Conservation Agriculture
 CT – Conventional Tillage
 CASC – Conservation Agriculture Service Center
 CASF – Conservation Agriculture Service with a Fee
 CAST – Commercialization of Aquaculture for Sustainable Trade
 CERAAS – Centre d’Etude pour l’Amélioration de l’Adaptation à la Sécheresse
 CE SAIN – Center of Excellence on Sustainable Agricultural Intensification and Nutrition
 CE MARCH – Center of Excellence on Mitigation, Adaptation and Resilience to Climate-Change in Haiti
 CGIAR – Consultative Group on International Agricultural Research
 CHCL – Campus Henri Christophe de Limonade
 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
 CSISA-MEA – Cereal Systems Initiative for South Asia – Mechanization Extension Activities
 CSIRO – Commonwealth Scientific and Industrial Research Organization
 DAEng – Department of Agricultural Engineering
 DAOUST – Dakar American University of Science and Technology
 DDL – Data Development Library
 DGFSC – Digital Tools, Geospatial and Farming Systems Consortium
 DICTA – Directorate of Science and Agricultural Technology
 EAB – External Advisory Board
 EMMP – Environmental Management and Mitigation Plan
 ENSA – École Nationale Supérieure d’Agriculture
 EAWAG – Swiss Federal Institute of Aquatic Science and Technology
 FAA – Federal Aviation Administration
 FABE – Faculty of Agricultural Biosystems Engineering

FAMB – Faculte d’Agronomie et de Medecine Veterinaire
 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
 IARC – International Agricultural Research Center
 ICRISAT – International Crops Research Institute for the Semi-Arid Tropics
 ICT – Institute of Technology of Cambodia
 ICTA - Institute of Agricultural Science and Technology
 IDRC – International Development Research Centre
 IDSS – Integrated Decision Support System
 IER – Institute of Rural Economy
 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
 IRRI – 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
 NUBB – National University of Battambang / University of Battambang
 NGO – Nongovernmental organization
 NM-AIST - Nelson Mandela African Institution of Science and Technology
 NUS – Neglected and underutilized species
 PDAFF – Provincial Department of Agriculture, Forestry and Fisheries
 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
 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
 STEM – Science, Technology, Engineering and Mathematics
 SSA – Sub-Saharan Africa
 SUA – Sokoine University of Agriculture
 TAMASA – Taking Maize Agronomy to Scale in Africa
 TP – Technology Park
 TRA – Technology Readiness Assessment
 UAV – Unmanned Aerial Vehicle
 UBB – University of Battambang / National University of Battambang
 UCNH – Université Chrétienne du Nord d’Haïti
 UNDH – University Notre Dame of Haiti
 UniQ – Quisqueya University
 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

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I. Executive Summary

The Feed the Future Innovation Lab for Collaborative Research on Sustainable Intensification (SIIL) successfully completed its ninth year since inception. This report covers activities completed during FY 2023 in Bangladesh, Burkina Faso, Cambodia, Guatemala, Haiti, Honduras, Niger, and Senegal. The SIIL continues to support the goal of developing an integrated research portfolio of sustainable intensification practices that offers the greatest potential to reduce hunger while improving the resilience and nutrition of smallholder farmers in the target regions. This fiscal year, SIIL has positioned itself to build on the achievements, reflect on lessons learned while ensuring the continued relevance of the research with a focus on leveraging regional efforts, scaling innovations, and strengthening local institutional and human capacity with the goal of working toward the *journey to self-reliance*.

During this past year, research projects and consortia have been working on scaling technologies and innovations with appropriate partners, while wrapping up their research. This report highlights the accomplishments and lessons learned during that time. Project teams had already identified promising innovations from their research by using a holistic approach by actively collaborating with strategic partners to leverage investments from both the public and private sectors. They were then able to communicate their successes through multiple knowledge management platforms, which have been key to successful implementation that will ensure greater impact, reach, and return on investments. The SIIL continues to strengthen, grow, and collaborate with over 120 national and international entities (including 9 CGIAR (Consultative Group of International Agricultural Research Centers) and 20 US universities) and has supported more than 200 students and young scientists to work toward increasing agriculture productivity and resilience of cropping systems and supporting nutritional outcomes.

This summary serves to highlight a few of the key achievements of SIIL from this past year: On August 1-3, 2023, the SIIL held its Annual Meeting in Somone, Senegal. There were over 100 participants over the course of the three days, and the SIIL showcased the collaboration between its consortia, focus country subawards, and initiatives. Representation included representatives of USAID, External Board Members, Kansas State University dignitaries, partners from all of our projects, consortia, and initiatives included colleagues from Guatemala.

Other highlights include a) successful completion of focus country projects, the Bean Study project, and the Appropriate Scale Mechanization Consortium (ASMC), b) the Center for Sustainable Agricultural Intensification and Nutrition (CE SAIN) at Royal University of Agriculture in Cambodia successfully launched two Agricultural Technology Parks (ATPs) and showcased its capacity by hosting two conferences with local and regional partners; c) the Center of Excellence on Mitigation, Adaptation, and Resilience to Climate-Change (CEMARCH) established virtual classrooms in four of the six universities. The ATPs are offering trainings and extension programs for farmers designed to help farmers improve crop production and develop climate-smart practices; and d) we have continued engagement and refinement of the activity tracker with the USAID Missions, Innovation Labs, and Accelerated Innovation Delivery Initiative (AID-I) to support communication, collaboration, and coordination activities in the USAID focus countries.

SIIL is committed to human and institutional capacity building as evidenced by the 109 short-term trainings offered to 8,781 individuals (3,183 women, 36%). During FY 2023, SIIL supported 65 students with 40% females. There were 28 Ph.D. students (29% female), 33 M.S. students (42% female), and 4 B.S. students (100% female). 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. Collectively, SIIL's researchers produced over 33 peer-reviewed publications and delivered over 45 presentations in FY 2023.

In addition to these key highlights and achievements, SIIL's consortia, focus country subawards, and initiatives had many accomplishments during this reporting period, and they are highlighted in the sections below.

II. Focus Country Key Accomplishments

Bangladesh

The Appropriate Scale Mechanization Consortium, (ASMC II), continued to concentrate on scaling up improved mechanization innovations and techniques. Additionally, the project, “Pathways of scaling agricultural innovations for sustainable intensification in the polders of coastal Bangladesh” moved forward with its work in polder communities focused on improved rice planting techniques and improved production and cultivation practices. Below are highlights from the projects that worked in Bangladesh during FY 2023:

ASMC II:

1. The ASM Innovation Hub (ASMIH)-Bangladesh jointly organized an international symposium on “Agricultural Transformation: Role of Appropriate Scale Mechanization and Postharvest Loss Reduction Innovations.” It was successfully held on November 9-10, 2022, in Dhaka, Bangladesh with over 200 participants including key stakeholders.
2. ASMIH-Bangladesh successfully conducted their study on the three different agribusiness models including single entrepreneur, single shed service points, and ground entrepreneur for custom hire service provisions of agricultural machines. All three models were found to be beneficial for the agricultural machinery service receiving farmers however, single shed service point is found more sustainable for benefits and maintaining livelihoods of the agriprenurship.

Pathways of scaling agricultural innovations for sustainable intensification in the polders of coastal Bangladesh

1. Implemented the Cluster-Based Farmer Field Schools (CFFS) at four Learning Hubs throughout the cropping year. This approach brought together two different models of Water Management Groups and Farmer Field Schools.
2. The Polder project established 21 Learning Hubs, including mini-learning hubs in Polder 30, and demonstrated the potential of HYV (high yielding variety) rice with improved water management.
3. Six service providers (wife and husband) harvested rice from 41 hectares of land and earned an increase in profit from \$169 to \$882 USD.

Burkina Faso

The ASMC II was also active in Burkina Faso during FY 2023. ASMC II continued to concentrate on scaling up the improved mechanization innovations and techniques, including improved oxen yokes and the no-till planter for use by women farmers. Below are the highlighted activities completed in Burkina Faso during FY 2023:

ASMC II:

1. ASMC – Burkina Faso held additional training sessions for students, farmers, artisans, and women farmers to help train them on the various forage chopper and planter technologies. Several farmer field days were held at different locations.
2. A six-day training session was organized and held for artisan training.

3. Three Farmer Field Days were organized. ASMC – Burkina Faso had 12 out of 13 region artisans that were trained to build choppers and planters.
4. Plans were developed and executed to train women on how to use the planter using a donkey, as many women do not have access to oxen. Based on a focus group study, training women to use the planter drawn by a donkey will help scale the technology.
5. Finalization of the ASMC innovation technical fact sheets were completed and submitted to SILL.

Cambodia

The S3 Cambodia: Scaling Suitable Sustainable Technologies worked to augment their research project to improve the diffusion and adoption of the innovations created through the first project. ASMC II also continued their activities in Cambodia, in conjunction with various partners, including NUBB (National University of Battambang), RUA (Royal University of Cambodia) and CE SAIN (Center for Sustainable Agricultural Intensification and Nutrition). Below are the highlighted activities completed in Cambodia during FY 2023:

ASMC II:

1. Twenty-five Seed Broadcasters were sold in Cambodia during this reporting period. A unit of Seed Broadcaster reaches 32 hectares on average, therefore approximately 800 hectares of land has been enhanced by Seed Broadcasters.
2. A new partnership with agricultural cooperatives in Battambang has strengthened the capacity building and commercialization of cover crops that are accessible and affordable for smallholder farmers.
3. Organized a field trip of 2nd and 3rd year students and lecturers from the faculty of Agricultural Biosystems Engineering at RUA to visit and learn on conservation agriculture (CA) machineries, CA production systems, survey with farmers, service providers, and extension workers for agronomic and economic assessment of CA production systems.

S3 Cambodia – Scaling Suitable Sustainable Technologies:

1. S3 Cambodia was able to successfully develop curriculum for vegetable grafting and have a successful competition among students. Students from multiple schools participated in tomato grafting competitions to learn new agricultural techniques.
2. Additional gardens were developed and have been used to train teachers and students about Wild Food Plants and how to use them. Experts have been invited to visit the schools and provide training on tree health, propagation, and maintenance.
3. The incorporation of the Provincial Department of Agriculture (PDAFF) into S3 Cambodia's work has been a huge achievement. The vision is to have PDAFF sustainably extend the technology of tomato grafting, transplanting, and plant management to farmers and achieve greater adoption.

Guatemala/Honduras

Economic impact of improved bean varieties in Central America and the USA:

The “Economic impact of improved bean varieties in Central America and the USA,” was a study lead by Michigan State University (MSU) and the International Center for Tropical Agriculture (CIAT), to evaluate and estimate the economic impact of investments made by the former Legume Innovation Lab program,

CIAT, and other organizations and universities on bean breeding. The evaluation was focused on the US (i.e., Michigan), Guatemala, Honduras, Nicaragua, and Haiti, with field trials conducted in Guatemala and Honduras. This project was completed in August 2023. Below are the highlights during FY 2023:

1. Data analysis was completed, and results will be presented in the form of two reports – one on Michigan and one on Central America.
2. All field activities were concluded, and a project team meeting was held in late November to go over the data collected and discuss results.
3. Key challenges of the project implementation this past year were the delays in getting DNA fingerprinting results and not getting these results for all the samples (e.g., for Haiti). For Haiti, the researchers were informed that the team helping in DNA extraction could not recoup data for more than 50% of the seed samples. This was due to a technical error on the part of the lab technician.

Niger/Senegal

The Senegal project, “Improving food and nutrition security of smallholder agro-pastoral farming systems by integrating crop-livestock-human nutrition in Senegal and Niger” strengthened the research and expanded its focus to encompass a more regional approach in West Africa. Below are the highlighted activities completed in Senegal and Niger during FY 2023:

Improving food and nutrition security of smallholder agro-pastoral farming systems by integrating crop-livestock-human nutrition in Senegal and Niger:

1. An agreement was made with the National Council for the Development of Nutrition that allowed women processors to integrate the products into the database of enriched flour suppliers, which is an important step in supporting market research.
2. The Senegal project worked with ENSA (École Nationale Supérieure d'Agriculture) to finalize the new feeding trail protocol and implemented the trail at ENSA using Souna 3 and SL 423 millet varieties produced during the 2022 rainy season.

Senegal

The ASMC II was active in Senegal during FY 2023. ASMC II continued to concentrate on scaling up the improved mechanization innovations and techniques, including improved no-till planter for use by women farmers. Below are the highlighted activities completed in Senegal during FY 2023:

ASMC II:

1. Part of the ASMC team offered a week-long short course to mechanization based on agricultural service provider business development at Dakar American University of Science and Technology (DAUST). The course was attended by 28 students and was well received.
2. DAUST students built a hydrostatic two-wheel tractor that hold much promise for smallholder farmers in Senegal. The students also built and tested an electric powered forage chopper.
3. Artisans in Senegal designed and tested two-row planters for power Ox. They performed well while needing minor refinements.

III. Research Program Overview and Structure

Digital Tools, Geospatial, and Farming Systems Consortium (DGFSC) – Building a New Era of Predictive Agricultural Innovation to Improve the Livelihoods of Smallholder Farmers

The Digital Tools, Geospatial, and Farming Systems Consortium (DGFSC) provided high-resolution soil, climate, crop, livestock, nutrition, and socioeconomic data. These datasets are helping to quantify past conditions and inform future changes in the adoption of different management practices to improve the overall resiliency and sustainability of agricultural systems in targeted regions in West Africa and Asia, as well as in the Feed the Future Zones of Influence. The consortium wrapped up their activities and below are the highlights based on their objectives:

- *Modeling tools*: examined mixed crop-livestock farming systems' suitability and land capability for agriculture productions in targeted regions.
- *Remote-sensing products*: assessed current conditions, trends, and potential future conditions in targeted countries.
- *Connection*: linked agricultural productive capacity and child malnutrition using livestock ownership, field size, use of improved seeds and fertilizer, and climate variability.
- *Resilience*: examined the potential implications of agricultural innovations on social and biophysical risk and resilience at local test sites in targeted regions.
- *Innovation integration*: developed geospatial products that were integrated 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 Appropriate Scale Mechanization Consortium (ASMC II)

The ASMC introduced multifunctional and modular mechanized technologies that were technically, environmentally, economically, and socially appropriate for use by smallholder farmers (including women) with the flexibility to accommodate different power sources. They completed their activities and were active in four countries. The developed technologies contributed to enhanced labor productivity and increased land productivity, thus sustainably reducing poverty among smallholders.

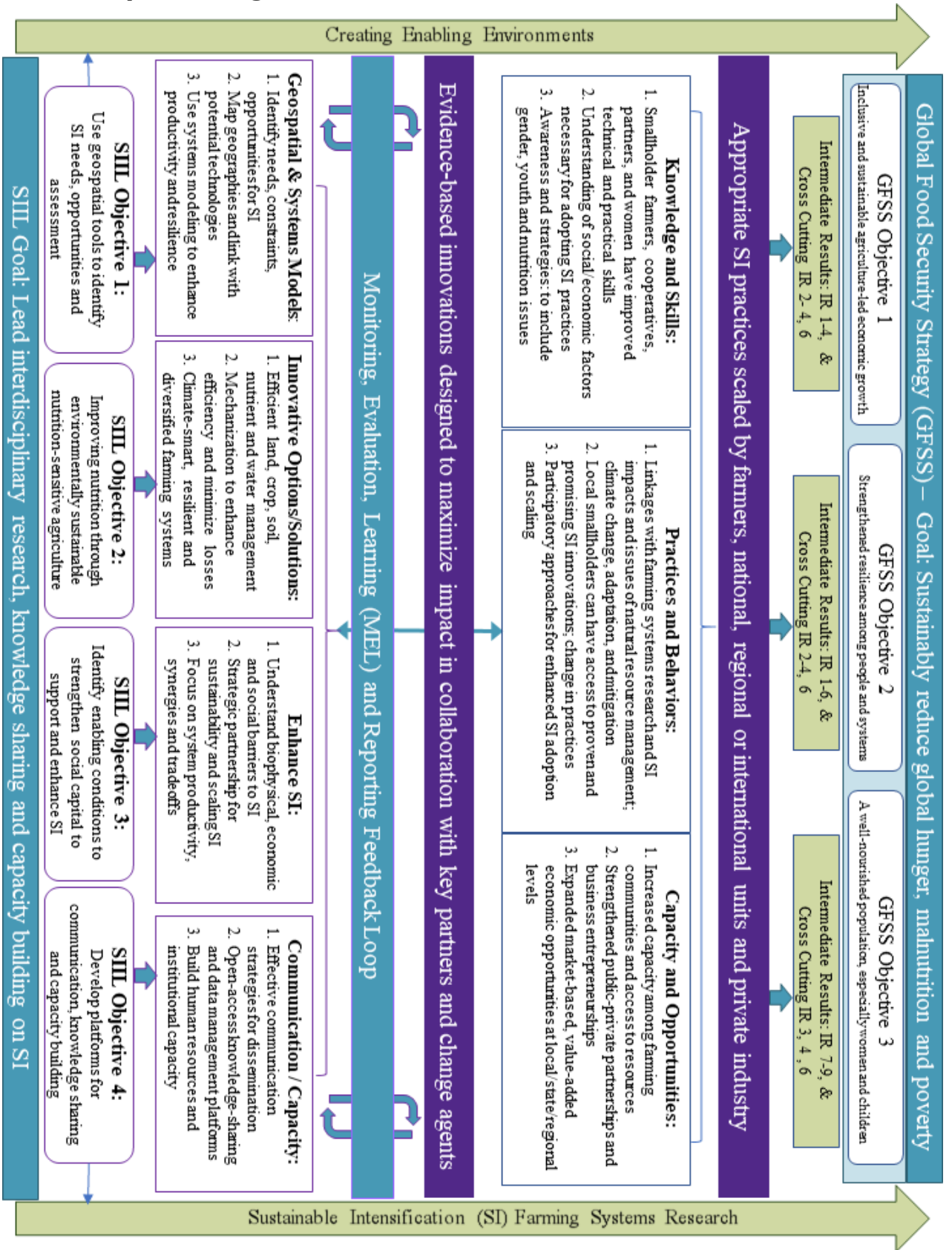
ASMC II worked on scaling its innovations in four countries – Bangladesh, Burkina Faso, Cambodia, and Senegal. The objectives for the consortium focused on the following goals:

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

Focus Country Research Subawards

The SIIL supported three country subawards (Bangladesh, Cambodia, and Senegal/Niger) in FY 2023. Together, the research project subawards have been investigating a diverse range of sustainable intensification practices and innovations across the SIIL 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 SIIL research subawards were implemented and led by collaborations between U.S. universities, NARES (National Agricultural Research, Extension and Service) centers, NGOs, and CGIAR partners. Summary highlights are shared in Research Project Reports in Section V of this report.

IV. Theory of Change



V. Research Project Reports

Theme I: Geospatial and Digital Tools

Digital Tools, Geospatial, and Farming Systems Consortium (FY2020 – FY 2023)

1. **Name:** Digital Tools, Geospatial, and Farming Systems Consortium (DGFSC, 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:** *United States* – aWhere, Corteva Agri-Science, Descartes Labs, Microsoft, Michigan State University, University of Colorado, University of Maryland, University of Minnesota; *Bangladesh* – International Rice Research Institute (IRRI); *Senegal* - Initiative Prospective Agricole et Rurale (IPAR), Centre of Excellence on Dry Cereals & Assoc. Crops, National Centre for Livestock Research, Kolda (CRZ), Senegalese Agricultural Research Institute (ISRA).
4. **Description and Achievements:** The DGFSC focused 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 DGFSC leadership team at Kansas State University.
 - **Modeling tools:** examined mixed crop-livestock farming systems' suitability and land capability for agriculture productions in targeted regions. Developed two review papers on livestock (Senegal and Bangladesh).
 - **Remote-sensing products:** assessed current conditions, trends, and potential future conditions in targeted countries. Assessed impact of climate scenarios in Bangladesh.
 - **Connection:** linked agricultural productive capacity and child malnutrition using livestock ownership, field size, use of improved seeds and fertilizer, and climate variability. Developed modeling framework which is currently under review.
 - **Resilience:** examined the potential implications of agricultural innovations on social and biophysical risk and resilience at local test sites in targeted regions. Adaptation strategies for water limited conditions were identified and reviewed.
 - **Innovation integration:** developed geospatial products that were integrated 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. Developed modeling framework which is currently under review. Country level data was collected for Senegal.
5. **Capacity Building:**
 - A PI of the consortium participated in the Sustainable Intensification of Agriculture for a Resilient Food System Symposim as a keynote speaker. This was held in Dakar, Senegal in August 2023.
 - Training videos were prepared detailing basic coding in R and basics on shiny app development.
 - Three female students were employed to work on crop yield estimation and integrated farm system modeling for Senegal.
6. **Lessons Learned:**
 - The consortium’s initial testing of long-term drought-vulnerability indices related to land capability classification showed promise. These indices included a focus on soils as a risk factor in drought impacts and the initial trials in the Peanut Basin suggest that the soil signal is an important potential aspect in drought risk.

7. **Presentations and Publications:**

Journal Articles

- 1) Moller, K. (July 2022). Livestock and aquaculture farming in Bangladesh: Current and future challenges and opportunities (pp. 2241274). *Cogent Food & Agriculture*, 9, UK
- 2) Brown, M. (January 2023). Integrated modeling framework for sustainable agricultural intensification(pp.1039962). *Frontiers in Sustainable Food Systems*, 6, Lausanne, Switzerland
- 3) Viera, N. (March 2023). Management Adaptations for Water-Limited Pearl Millet Systems in Senegal (pp.108173). *Agricultural Water Management*, 278, Amsterdam, Netherlands
- 4) Carcedo, A. (March 2023). The urgency for investment on local data for advancing options for improving crop productivity and climate resilience assessments in Africa: a review for APSIM crop modeling (pp.105633). *Environmental Modelling and Software*, 161, Amsterdam, Netherlands
- 5) Gerber, J. S. & West, P. Global yield gap time trends reveal regions at risk of future crop yield stagnation. *Nature Food* (in review)
- 6) Banda, E. Unveiling the power of regional water stress analysis and advanced predictive modeling. *Agricultural Water Management*
- 7) Moller, K. Unveiling the resilience of smallholder millet and groundnut producers in Senegal amidst extreme climate conditions. *Food and Energy Security* (in review)
- 8) Yin, L., Rahul, R., Chenxi L., Hale, D., Weigl, C.... (September 2023). Mapping smallholder cashew plantations to inform sustainable tree crop expansion in Benin (pp.113695). *Remote Sensing of Environment*, 295(2023), Amsterdam, Netherlands. doi:<https://doi.org/10.1016/j.rse.2023.113695>. 0034-4257.
- 9) Guan, K., Jin, Z., Peng, B., Tang, J., DeLucia, E.... (August 2023). A scalable framework for quantifying field-level agricultural carbon outcomes (pp.104462). *Earth-Science Reviews*, 243(2023), Amsterdam, Netherlands. doi:<https://doi.org/10.1016/j.earscirev.2023.104462>. 0012-8252.
- 10) Brown, M. (April 2023). Data scarcity limits understanding of hydroclimatic drivers of food and urban security. (pp.315–316). *Nature Water*, 1, London, UK.
- 11) Nieto, L. Limitations and future perspectives for satellite-based soil carbon monitoring. *Science of the Total Environment*. (in review)
- 12) Viera, N. Management interventions of pearl millet systems for attaining cereal self-sufficiency in Senegal. *Frontiers In Sustainable Food Systems*. (in review)
- 13) Tedesco, D. Mapping and assessing adoption rate of rice varieties in the coastal zone of Bangladesh using SAR time series. *Computers and Electronics in Agriculture*. (in review)
- 14) Burrows, R. Considering soil moisture in models of climate impacts on child health in farming centric countries. *Population and Environment*. (in review)
- 15) Gomez, F. A dataset for soil organic carbon in agricultural systems for the Southeast Asia region. *Scientific Data*. (in review)
- 16) Nocera Santiago, G. Data Integration Dashboard for Assessing and Planning Sustainable Intensification Agricultural Interventions: A Case Study in Senegal. *Frontiers in Sustainable Food Systems*. (in review)
- 17) Indez, C. M., Faye, A., Ly, M. O., Stewart, Z. P., Prasad, V.... (September 2021). Soil and Climate Characterization to Define Environments for Summer Crops in Senegal (pp.11739). *Sustainability*, 13(2021), Basel, Switzerland. doi:10.3390/su132111739. 2071-1050.

Conference/Presentations

- 1) Nieto, L. (December 2022). Assessment between in-situ observations and remote sensing products. Presentation at American Geophysical Union Annual Meeting, Chicago, IL.
- 2) Ciampitti, I. A. (June 2023). The need for local data for moving forward food assessments in Africa: a review using sorghum crop modeling as a case study. Presentation at Sorghum in the 21st Century: Resiliency and Sustainability in the Face of Climate Change, Montpellier, France.
- 3) Carcedo, A. (June 2023). Sorghum crop comparison to assess stability of food production in Senegal. Presentation at Sorghum in the 21st Century: Resiliency and Sustainability in the Face of Climate Change, Montpellier, France.
- 4) Moller, K. (September 2023). Assessing the Resilience of Smallholder Millet and Groundnut Producers in Senegal to Climate Variability and Changes. Presentation at American Geophysical Union, San Francisco, US.
- 5) Brown, M., Carcedo, A., Eggen, M., Grace, K., Neff, J., & Ciampitti, I. A. (December 2022). Integrating agriculture and agronomic models with social and demographic modeling to accelerate sustainable agricultural intensification. Presentation at American Geophysical Union meeting in Chicago, Chicago, IL.
- 6) Hernandez, C. (November 2022). Digital and Geospatial Tools to define climate zones in Senegal. Presentation at ASA-CSSA-SSSA International Annual Meeting, Baltimore, US.
- 7) Viera, N. (November 2022). Management Adaptations for Water-Limited Pearl Millet Systems in Senegal. Presentation at ASA-CSSA-SSSA International Annual Meeting, Baltimore, US.
- 8) Burrows, R. (December 2022). Early Growing Season Climate and Population-Environment Linkages Across West Africa. Presentation at American Geophysical Union meeting, Chicago, IL.
- 9) Gerber, J. S. (August 2023). A Global View of Sustainable Intensification. Presentation at Sustainable Intensification of Agriculture for a Resilient Food System Symposium., Dakar, Senegal.
- 10) Carcedo, A. (November 2022). Assessing Impact of Salinity and Climate Scenarios on Dry Season Field Crops in the Coastal Region of Bangladesh. Presentation at ASA-CSSA-SSSA International Annual Meeting, Baltimore, US.
- 11) Nieto, L. (November 2022). The Dilemma of Low-Quality Ground-Truth Data, an Exercise in Senegal. Presentation at ASA-CSSA-SSSA International Annual Meeting, Baltimore, US.

Theme II: Appropriate Scale Mechanization for Smallholder Farmers

Summary of ASMC II Activities

1. **Name:** Appropriate Scale Mechanization Consortium (PI: Prasanta Kalita, University of Illinois at Urbana-Champaign)
2. **Locations:** Bangladesh, Burkina Faso, Cambodia, and Senegal
3. **Description:** The ASMC facilitated 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 was to sustainably intensify smallholder farmers' cropping systems and on-farm operations through mechanization. The ASMC utilized a user-centric systems approach through an Innovation Hub model in each of their four focus countries. The Hubs identified specific mechanization needs, leveraged ASMC resources accordingly, and implemented innovative solutions.
4. **Collaborators:** *United States* – Kansas State University, Michigan State University, and North Carolina A&T State University, ADM (Archer Daniels Midland) Institute for the Prevention of Postharvest Loss (Illinois). Additional international collaborators are listed under the country report.
5. **Achievements:**
 - The ASMC team completed the Africa and Asia Agricultural Mechanization Status Survey reports. A total of 1,325 individuals participated in the Africa survey, and a total of 1,029 individuals participated in the Asia survey.
 - Following the Agricultural Mechanization Status Survey that was conducted by the ASMC team, an Agricultural Mechanization Summit was organized and hosted in Senegal on October 11-12, 2022. This was attended by 32 invited thought leaders in Africa from academia, research organizations, FAO, and the private sector.
 - ASMC successfully accomplished strengthening the ties between the Asian and African collaborators by traveling to Bangladesh with ASMC Senegal Coordinator, Aliou Faye. Both country researchers exchanged their work and ideas on opportunities and challenges of agricultural mechanization.
6. **Capacity Building:**
 - Maria Jones supported regional/country leads in gender integration into existing activities such as ensuring extension materials are gender sensitive and needed trainings.
7. **Lessons Learned:**
 - It was recommended that the Bangladesh researchers share some of their design considerations with the Senegal partners, to help in fabricating the BAU (Bangladesh Agricultural University) - STR dryer for crop drying in Senegal.
8. **Presentations and Publications:**
 - See individual ASMIH reports for publications and presentations created during FY 2023.

ASMC II – 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 was promoting appropriate-scale agricultural mechanization for sustainable intensification focused on smallholder farming systems in Southern Delta region of Bangladesh. The target equipment interventions included 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, Bangladesh Agricultural Research Institute, and ACI Motors Ltd.
5. **Achievements:**
 - An Agricultural Mechanization Status Survey was conducted prior to this reporting period. The survey reports conducted in Africa and Asia can be given upon request.
 - Following the survey, a mechanization summit was organized in Senegal on October 11-12, 2022, which was attended by 32 invited thought leaders from different locations in Africa from academia, research organization, FAO (Food and Agriculture Organization), and the private sector.
 - ASMIH – Bangladesh provided technical assistance to synchronize farming at Dumuria and Botiagata, Khulna which was organized by the Department of Agricultural Extension (DAE).
 - IoT based Solar Drip Irrigation System based technology park was established at the premises of the Department of Farm Power and Machinery, Bangladesh Agricultural University, Mymensingh in November 2022.
 - BX-305 Real-time Kinematic Global Navigation Satellite System (RTK GNSS) has been used to estimate real time field data/parameters of the rice transplanter, combine harvester, and seeder. This included the mapping of land, determination of field capacity, and efficiency.
6. **Capacity Building:**
 - Thirty students from Sylhet Agricultural University have visited the CA park to learn about conservation agriculture and related machinery.
 - Thirty students from the Faculty of Agricultural Engineering and Technology, Bangladesh Agricultural University, Mymensingh have also visited FMPE divisional CA activities.
 - The capacity of field mechanics under ASMIH – Bangladesh has continuously improved through providing machinery-based services to smallholder farmers and entrepreneurs in the fields.
 - A total of 23 trainings were provided to 477 participants (male: 430 and female: 47) of Netrakona, Mymensingh, Habiganj, Gazipur, Barguna, Khulna, Barishal, Patuakhali during the October 2022 to September 2023 reporting period.
 - In addition to these trainings, 17 field-day programs were arranged on the combine harvester, rice transplanter operations, and CA machinery where a total of 530 participants were present.
7. **Lessons Learned:**
 - The ASMIH – Bangladesh team have learned that the development of different disseminations materials including leaflets, flyers, trainings, and business modules are very effective tools to convey messages about the benefits of agricultural machinery.
 - Empirical research evidence on agro-machinery based entrepreneurship development in the Bangladesh context is rare. Research in this regard is a time demand for sustainable development of such entrepreneurship in the country.

8. **Presentations and Publications:**

Journal Articles

- 1) Alam, M., Saha, C. K., Ali, M., Ahamed, S., Mozumdar, L., Hossain, M. M., & Kalita, P. (July 2023). Agripreneurial Models for Sustainable Agricultural Mechanization in Bangladesh. ASABE 2023 Annual International Meeting, Hilton Omaha, Nebraska, and CHI Health Center. doi: <https://doi.org/10.13031/aim.202300386>.

Conference/Presentations

- 1) Alam, M., Saha, C. K., Ali, R., Begum, I. A., Rahman, A., & Ahamed, S. (November 2022). Post-Harvest Loss Reduction Innovation Lab (PHLIL)-Bangladesh.
- 2) Alam, M. (November 2022). Agricultural Transformation of Bangladesh: Role of Appropriate Scale Mechanization.
- 3) Alam, M. (January 2023). Smart Bangladesh: Smart Agriculture.
- 4) Alam, M. (February 2023). Sustainable Agricultural Mechanization in Bangladesh: Challenges and Opportunities.
- 5) Tasnim, N., Mozumdar, L., Farid, K. S., Saha, C. K., & Alam, M. (November 2022). Patterns and Process of Agro-machinery-based Entrepreneurship in Southern Delta of Bangladesh.
- 6) Alam, M. (November 2022). Agricultural Transformation: Way Forward in Appropriate Scale Mechanization and Postharvest Loss Reduction Innovations.
- 7) Saha, C. K. (November 2022). ASMIH-Bangladesh: Innovative Approach to Scale Agricultural Mechanization.
- 8) Alam, M. (November 2022). Agricultural Transformation of Bangladesh: Role of Appropriate Scale Mechanization and Postharvest Loss Reduction Innovations.
- 9) Alam, M., Saha, C. K., Ali, R., Ahamed, S., & Sarkar, S. (November 2022). Technology Park: Knowledge Sharing and Service Platform for Agricultural Mechanization.
- 10) Alam, M., Saha, C. K., Ali, M., Mozumdar, L., Ahamed, S., & Sarkar, S. (November 2022). Single Shed Service Point (S3P): A Noble Approach to Sustainable Agricultural Mechanization.
- 11) Hoque, M., Hossain, M., Alam, M., Alam, M., & Saha, C. K. (November 2022). Conservation Agriculture Park: A Unique Demonstration Platform in Bangladesh.
- 12) Sarkar, S., Saha, C. K., M., Hossain, M. M., & Alam, M. (November 2022). Adaptation of Rice Transplanter Technologies in Southern Delta of Bangladesh.
- 13) Ahamed, S., Saha, C. K., Sarkar, S., & Alam, M. (November 2022). BAU Recirculating Paddy Dryer: Appropriate Scale Drying Solution for Major Rice Mill.
- 14) Gope, S. N., Ali, R., Awal, M., Ahamed, S., Saha, C. K., & Alam, M. (November 2022). Hermetic Cocoon: An Appropriate Solution for Large Scale Paddy Seed Storage.
- 15) Shawon, M., Ali, R., Saha, C. K., Ahamed, S., Joy, A. B., Sarkar, S., & Alam, M. (November 2022). Implementation Scope of Rice Transplanter and Harvesting Machines using GIS.
- 16) Nishat, N., Mozumdar, L., Saha, C. K., & Alam, M. (November 2022). Modern Agrotechnology, Women Empowerment and Poverty Reduction Nexus: Empirical Evidence on BAU-STR Dryer.
- 17) Saha, C., Sarkar, S., & Alam, M. (July 2022). Synchronized paddy cultivation using mechanical rice transplanting technology in Bangladesh. ASABE 2022 Annual International Meeting, Houston, Texas, USA.
- 18) Hossain, M., Hoque, M., Alam, M., Alam, M., & Saha, C. (July 2022). Establishment of a CA park to investigate long term conservation agriculture practices to improve soil health for sustainable crop production. ASABE 2022 Annual International Meeting, Houston, Texas, USA.

- 19) Alam, M. Climate Change: Agricultural Machinery as Mitigation Measures.
- 20) Alam, M. Fourth Industrial Revolution (4IR) and Climate Smart Agricultural Mechanization in Bangladesh.
- 21) Alam, M. (May 2023). Smart Agricultural Technology for Ensuring Food Security in Bangladesh.
- 22) Sarkar, S., Alam, M., Saha, C. K., Khan, I. N., M., & Hossain, M. M. (November 2022). Mechanical Rice Transplanting: A New Business Opportunity for Bangladesh Agropreneuers. 3rd Annual Paper Meet, Agricultural Engineering Division, Institute of Engineers Bangladesh, 17-19 November 2022, p-53., Gazipur.
- 23) Ali, M., Sayeed, M., Saha, C. K., & Alam, M. (November 2022). Prospect of an IoT based E-advice System for Combine Harvester in Bangladesh. Third Annual Paper Meet 2022, Gazipur.
- 24) Hasan, M., Ali, M., Saha, C. K., & Alam, M. (November 2022). Suitability Analysis of Paddy Harvester in Southern Delta of Bangladesh Using GIS and Remote Sensing. 3rd Annual Paper Meet, Agricultural Engineering Division, Institute of Engineers Bangladesh, 17-19 November 2022, p-24., Gazipur.

Others

- 1) Alam, M. (December 2022). Fourth Industrial Revolution (4IR) and Agricultural Mechanization in Bangladesh.
- 2) Alam, M., Ahmed, M., Khan, F. H., Khan, I. N., Saha, C. K.... (February 2023). Sustainable Agricultural Mechanization in Bangladesh: Challenges and Opportunities.
- 3) Hasan, M., Ali, M., Saha, C. K., & Alam, M. (December 2022). Scope of paddy harvesting technologies through cropland mapping using GIS tools and remote sensing(pp.250-267). Fundamental and Applied Agriculture, 7(4), Bangladesh.
- 4) Saha, C. K. (November 2022). Circular Food Systems with Adaptation of Smart Agriculture for Combating Climate Change and Ensuring Food Security in Bangladesh.
- 5) Alam, M. (December 2022). Single Shed Service Point in Bangladesh.

ASMC II – 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, University Nazi Boni (UNB), Bobo-Dioulasso; *United States* - Tillers International.
5. **Achievements:**
 - ASMC – Burkina Faso had 12 out of 13 region artisans that were trained to build choppers and planters.
 - Plans were developed and executed to train women on how to use the planter using a donkey, as many women do not have access to oxen. Based on a focus group study, training women to use the planter drawn by a donkey will help scale the technology.
 - Additional training sessions for students, farmers, artisans, and women farmers were held to train them on the various forage chopper and planter technologies. Several Farmer Field Days were held at different locations.
 - Finalization of the ASMC innovation technical fact sheet was accomplished.
 - Three farmer field days were organized by ASMC – Burkina Faso.
6. **Capacity Building:**
 - The team involved several students from the Institute of Rural Development from the University of Nazi Boni in the various aspects of our project. Many students have completed their Master thesis on topics related to the project.
 - ASMC – Burkina Faso held additional training sessions for students, farmers, artisans, and women farmers to help train them on the various forage chopper and planter technologies. Several farmer field days were held at different locations.
7. **Lessons Learned:**
 - The Hub relayed that they had positive leadership regardless of the travel restrictions in Burkina Faso. They relayed that the in-country project director should take personal interest in the projects to provide positive results.
8. **Presentations and Publications:**

Conference/Presentation

- 1) Millogo, V. (November 2022). Innovation Laboratory/Process of some agricultural innovations developed at Nazi Boni University (Bobo-Dioulasso). Training on research results and innovations, Norbert ZONGO University (Koudougou, Burkina Faso).

ASMC II – 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 included:
 - design and assess conventional and direct seeding mulch-based cropping systems.
 - assess the performance of appropriate scale machinery while preserving soil capital.
 - adapt and train smallholder farmers, service operators, field technicians, and students on the use of ASM and conservation agriculture (CA)-based cropping systems.
 - support multi-stakeholder initiatives.
 - 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), Department of Agricultural Land Resources Management (DALRM); *France* – CIRAD; *Philippines* - Southeast Asian Regional Center on Graduates Studies and Research in Agriculture (SEARCA); *United States* – United States Department of Agriculture, Agricultural Research Service National Soil Dynamics Lab (USDA-NSDL)
5. **Achievements:**
 - Promotional activities including demonstration, field showcase, promotional materials, and sale activities were conducted to scale up the adoption of the technologies.
 - The second issue of the ASMC newsletter was designed in both English and Khmer languages and has been printed.
 - Twenty-five seed broadcasters were sold during this reporting period. Considering the previous assessment report, approximately 800 hectares of land is improved by these seed broadcasters.
6. **Capacity Building:**
 - A training course on Open System Agriculture Machinery Design and Manufacturing was organized and provided to more than 40 participants, representatives of private companies, local manufacturers, researchers, academic staff and students, and governmental staff.
 - The new partnership with agricultural cooperatives in Battambang has strengthened the capacity building and commercialization of cover crops that is accessible and affordable for farmers.
 - ASMIH – Cambodia organized a field trip of second- and third-year students and lecturers from the faculty of Agricultural Biosystems Engineering at RUA to visit and learn about CASI machineries and CA production systems.
7. **Lessons Learned:**
 - The price of cover crop seeds is still high for smallholder farmers, making the adoption rate stay low. The strategic direction to work with the agriculture cooperatives is important in overcoming this issue.
 - The price of CA service provision is not high enough yet to convince service providers to invest in a no-till planter. This becomes an additional challenge to sell no-till planters unless sold through a service discount.
8. **Presentations and Publications:**
 - None to report for this reporting period.

Theme III: Rice Fallows and Horticulture – South Asia

- **Bangladesh**

1. **Name:** Pathways of scaling agricultural innovations for sustainable intensification in the polders (PI: Sudhir Yadav, IRRI)
2. **Locations:** Polder 30 in the Khulna district of Bangladesh
3. **Description:** The primary objective of the project was to increase farm income and nutrition security by intensifying polder farming systems through implementation of sustainable and economically viable practices. Specifically, the project aimed 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* – BRAC, Bangladesh Agricultural University, IRRI, IWM, Khulna University, Patuakhali Science and Technology University, Sher-e-Bangla Agricultural University, Shushilan; *United States* - Kansas State University, Arkansas State University
5. **Achievements:**
 - A major achievement of this reporting period for the project was the implementation of Cluster-Based Farmer Field Schools (CFFS) at four learning hubs throughout the cropping year. This is an approach that brings together two different models of water management groups and farmer field schools. The CFFS is led by the Department of Agricultural Extension (DAE) with technical support from the SIIL-Polder project.
 - The project established 21 learning hubs (including mini-learning hubs in Polder 30) and demonstrated the potential of HYV rice, and early establishment and semi-mechanized cultivation of maize and sunflower in the Polder zone with improved water management.
 - Six service providers (wife-husband) harvested rice from 41 hectares and earned an increased income from 169 USD to 882 USD during this reporting period. They adopted a business model to generate income by spending their earnings on the most productive purposes for their family and agricultural business.
6. **Capacity Building:**
 - The project organized 15 capacity building programs and imparted training to 5,643 individuals, most of whom were producers (92%). Among those who were trained, 39% were women and 14% were youth.
 - The project established 19 learning hubs in the aman and rabi seasons, and organized traveling seminars and field visits at key growth stages of crops and during key mechanization activities to enhance peer-to-peer learning among different stakeholders. These cross-visit programs were attended by 2,500 individuals from different sections of society. Of the participants, 42% were women and 17% were youth.
7. **Lessons Learned:**
 - Monitoring of river water salinity is an important component of water management in coastal polder regions for the establishment of rice in aman season, as well as operation of the sluice gate for raising seedlings, land preparation, and the transplanting of HYV rice.
 - The shortage of agricultural machinery, mechanics, and service providers remains a documented challenge for attracting farmers to use machines. Geography plays a significant role in scaling the use of machinery since transporting machines within the polder zone can be challenging due to poor roads and intensive canal networks.
 - The CFFS model that the SIIL-Polder project developed could aid in addressing adverse climate events (like drought at the early stage of the wet season in 2022) to sustain the productivity of the coastal zone.

- The shortage of agricultural machinery, mechanics, and service providers remains a documented challenge for attracting farmers to use machines. Geography plays a significant role in scaling the use of machinery since transporting machines is difficult due to poor roads and intensive canal networks.

8. **Presentations and Publications:**

Journal Articles

- 1) Nath, D. K., Yadav, S., Mondal, M., M, M., Nishanka, J., & Jagadish, K. Are the water management organizations of the polder zone of Bangladesh positioned to accept the responsibility to address food security challenges in deltas?. *International J. of Water Governance*.
- 2) Singaraju, N. What influences women's participation in water governance? Learning from coastal polder zones of Bangladesh using mixed methods. *World Development*.
- 3) Tedesco, D., Carcedo, A., Nieto, L., Prasad, V., Mondal, M..... Mapping and assessing adoption rate of rice varieties in the coastal zone of Bangladesh using SAR time series. *Computers and Electronics in Agriculture*.

Conference/Presentations

- 1) Yadav, S., Mondal, M., & Batas, M. A. (August 2023). SIIL Annual Meeting 2023 Presentation.

Others

- 1) Mandal, S., Parvin, R., Sarker, S., Ali, M., Sarker, M.... (July 2023). *Polder Tidings* Volume 3, Number 4, July 2023.
- 2) Flor, R., Cook, S., L. M., & Yadav, S. (January 2022). Toolkit for Facilitating Learning Alliance and other multi-stakeholder platforms.

• **Cambodia**

1. **Name:** S3-Cambodia: Scaling Suitable Sustainable Technologies (PI: David Ader, University of Tennessee, UT)
2. **Locations:** Siem Reap, Kampong Thom, Battambang, Kampong Cham and Phnom Penh, Cambodia
3. **Description:** The Scaling Suitable Sustainable Technologies (S3-Cambodia) project supported agents to scale suitable and sustainable technologies in Cambodia. S3-Cambodia advanced the capacity and roles of scaling agents in technology diffusion through applied research, technical assistance, curricula development and organizational strengthening. This process demonstrated 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. **Achievements:**
 - A major achievement of the S3 project this reporting period was the development of curriculum for vegetable grafting and the successful competition among students. Students from multiple schools participated in tomato grafting competitions to learn new agricultural techniques. Science content was taught in the classroom to reinforce skills and knowledge gained through growing the grafted tomatoes.

- The S3 project was able to successfully develop additional gardens. There was continual monitoring of the gardens and train teachers and students about Wild Food Plants and how to use them.
- Incorporation of the Provincial Department of Agriculture (PDAFF) into the S3 work. Swisscontact and National University of Battambang organized a training of trainers for PDAFF on tomato grafting, transplanting, and plant management. The training aims to integrate PDAFF into the technology pathway of grafted tomato plants with the visionary of having PDAFF sustainable extend the technology to farmers and achieve greater adoption.
- A cover crop seed production system was successfully developed, and due to the high demand, there is a need for seed production. Collaborating with the Department of Agricultural Land Resources Management (DALRM), Battambang Union Agriculture Cooperative (BUAC), and SmartAgro company, there has been a contract with farmers to produce cover crop seed.

6. **Capacity Building:**

- The extension system in Cambodia is changing, and the government now wants to add more extension agents into the communes. This will require training by CE SAIN but will also provide more help spreading the grafting technology and business plans into the communes.
- S3-Cambodia connected with Baby Bird farm, a large private farm in Kampot that produces vegetables, fruits, and pepper. They were able to engage the owners, and the 120 staff that work the +100 hectares. They are helping to increase their capacity for conservation agriculture techniques and grafting technologies.
- The project provided training to three high school teachers as a Training of Trainers, including conservation agriculture, vegetable grafting, and wild food plant production. They have also provided capacity building with Hun Sen Treng High School in Battambang, Meanchey Primary School in Battambang, and Kangan Secondary School in Pursat, and the National Meanchey University.

7. **Lessons Learned:**

- Since S3-Cambodia has worked with so many schools, they relayed that proper management and coordination of all relevant stakeholders is extremely important. As an example, if the supervisor of the teacher is not advised or included in the discussion and planning of agricultural training at the school, they may not be supportive of agriculture at their school.
- Working with the private sector such as the plant nursery business, it can be challenging because even with the potential profit, the high labor and time demands coupled with environmental uncertainties make farmers hesitant to adopt.

8. **Presentations and Publications:**

Journal Articles

- 1) Ader, D. R., Pekarcik, G., & Gill, T. Assessing Impact of Parental Involvement on Scaling Agricultural Technologies from School Garden to Home Farm. *Journal of Agriculture, Food Systems and Community Development*.
- 2) Pekarcik, G., Ader, D. R., & Gill, T. Impact of Conflict on Agricultural Practices and Transitions in Cambodia. *Culture, Agriculture, Food and Environment*.

Conference/Presentations

- 1) Pekarcik, G., Goertz, H., Ader, D. R., & Gill, T. (August 2022). Scaling Suitable, Sustainable Technologies for Smallholder Farmers in Cambodia. 31st International Horticultural Congress, 2022, Angers, France.

Theme IV: Crop-Livestock Interactions – West Africa

• **Senegal and Niger**

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; and 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 focused 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 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. If a farming systems approach is used, then this will guide the dissemination of technologies 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 Thiès - 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. **Achievements:**
 - Partnering with ISRA – CNRA during 2023 alone, the work of large-scale dissemination of three agricultural innovations has contributed to significantly exceeding the number of hectares and farmers who were targeted by the project.
6. **Capacity Building:**
 - Successful trainings were had with several groups of women on the transformation process of enrichment of millet flour, which increased income as well as the addition to the qualitative improvement on the status of pregnant women and malnourished children.
 - A training workshop was held for investigators on September 15-16, 2023, at BAME.
7. **Lessons Learned:**
 - The availability of sufficient quantities of seeds of certain varieties still remains a major challenge, and definitive solutions should be considered with partners in the development of agriculture and food security in Senegal.
8. **Presentations and Publications:**

Journal Articles

- 1) Faye, A.; Akplo, T.M.; Stewart, Z.P.; Min, D.; Obour, A.K.; Assefa, Y.; Prasad, P.V.V. Increasing Millet Planting Density with Appropriate Fertilizer to Enhance Productivity and System Resilience in Senegal. *Sustainability* 2023, 15, 4093. <https://doi.org/10.3390/su15054093>.
- 2) Jha, P.K.; Middendorf, G.; Faye, A.; Middendorf, B.J.; Prasad, P.V.V. (2023). Lives and Livelihoods in Smallholder Farming Systems of Senegal: Impacts, Adaptation, and Resilience to COVID-19. *Land* 2023, 12,178. <https://doi.org/10.3390/land12010178>.

Conference/Presentations

- 1) Min, D. USAID Sustainable Intensification Projects in Senegal, and US University Systems.
- 2) Min, D. USAID Sustainable Intensification Innovation Lab Project in Senegal, and Exploring Potential Forage Crops for Indian Farmers.
- 3) Min, D. USAID Sustainable Intensification Innovation Lab Project in Senegal, and Exploring Potential Forage Crops for Nepalese Farmers.
- 4) Mbodji, S. M. K., Faye, A., Diouf, D., Stewart, Z. P., Prasad, V. P.... (August 2023). USAID SIIIL Annual Meeting Poster Presentation. Presentation at SIIIL Annual Meeting, Somone, Senegal.

VI. Associate Award Research Project Reports and Initiatives

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:** 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 - Cambodian Agricultural Research and Development Institute (CARDI), Conservation Agriculture Service Center (CASC); Ministry of Agriculture Forestry and Fisheries (MAFF); Ministry of Education, Youth, and Sport (MoEY); Department of Agricultural Engineering (DAEng); Provincial Department of Agriculture, Forestry and Fisheries (PDAFF), 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 (American Soybean Association-Commercialization of Aquaculture for Sustainable Trade) project include American Soybean Association, World Vision, and Auburn University.
5. **Achievements:**
 - The U.S. Ambassador to Cambodia W. Patrick Murphy and the Minister of Agriculture, Forestry and Fisheries, H.E Dith Tina launched Center of Excellence on Sustainable Agricultural Intensification and Nutrition (CE SAIN) Agricultural Technology Park (ATP) in the Provincial Department of Agriculture, Forestry and Fisheries (PDAFF) in Mondulkiri province on January 26, 2023. The event was hosted by the CE SAIN.
 - CE SAIN has strengthened their partnerships and engagements with the private sector by supporting the Cambodia Conservation Agriculture and Sustainable Intensification Consortium (CASIC) and the Provincial Department of Agriculture, Forestry and Fisheries (PDAFF) led by the MetKasekor Extension Model. The model has resulted in private entrepreneurs being engaged in providing machinery services for farmers on improved land management.
 - CE SAIN hosted 26 (58% female) interns at the ATPs. These interns received hands-on experience and technical training through the CE SAIN Agricultural Internship Curriculum.
 - Agricultural Extension Program practices were extended at the ATPs to farmers and four participating institutions, including local non-government organizations and technical high schools. 867 individuals (492 females, 57%) were engaged in agriculture activities under the framework of Mini-ATPs.
 - Activities were coordinated in 7 projects: 1) Scaling Suitable Sustainable Technologies (S3-Cambodia), 2) Bighead Catfish Culture, 3) Commercialization of Aquaculture for Sustainable Trade (CAST), 4) Cambodian Sustainable Intensification Farmer-to-Farmer Program, 5) Reducing Foodborne Pathogen Contamination of Vegetables, 6) “Strengthening the Climate Resilience of Agricultural Systems in Cambodia and Viet Nam’ (CRAS), and 7) Food and Agriculture Organization of the United Nation.

- Five sub awards were granted to: 1) Faculty of Veterinary Medicine on laboratory improvement, 2) Faculty of Agricultural Biosystems Engineering on Vegetable Planter Installment, 3) MAFF for Soil sample collection and analysis research, 4) CIRAD on MetKasekor Model and 5) CASIC on support CA and SI.
- Agri-business plans for the ATPs were developed, including a business plan manual, data analysis, and branding development to further link the agriculture products from ATPs to the market. These plans serve as models for smallholder farmers for adoption to increase their capacity in farm operation, income generation, and sustainability of their farm productivity. First-hand information was collected on consumer behavior of safe vegetables.
- Thirty unique technologies are being showcased in seven of the Agricultural Technology Parks (ATPs), 4 are in Phase II, 23 are in Phase III and 3 are in Phase IV of development.
- CE SAIN is engaged with the Digital Tools, Geospatial and Farming Systems Consortium (DGFSC) at Kansas State University to link farming systems with geospatial approaches and provide training to strengthen the Royal University of Agriculture's geospatial department.
- CE SAIN has also partnered with AgriFoSe-Cambodia on Digital Extension Services Project to support a master's student to continue to conduct research related to leveraging digital technologies and ecosystems.

6. **Capacity Building:**

- CE SAIN provided 13 long-term degree granting opportunities. Of the 13 supported students seeking long term degrees, 54% are females. Eight are pursuing Master's degrees, five (63%) are females, and of the five students are pursuing PhD's, 2 are female. The PhD scholars' research focuses on agricultural extension and communication, the MS scholars' studies focus on public administration, Aquatic Biology and Crop Science.
- Individuals participating in USG food security programs through CE SAIN plus partners short term trainings conducted by CE SAIN had 2,124 (1,038 females, 49%) which included high school students, farmers, labors at the ATPs, interns, service providers, private sectors, government representatives, and people from civil society.
- There were 16 training/lecture series by C2SK and CE SAIN. The ATPs showcase innovations and technologies to promote sustainable development and extended learning through the various visitations (1,470 visitors in FY2023), 40% were females.

7. **Lessons Learned:**

- Unfavorable weather conditions, including heat, flood, and extended drought, caused damage to vegetable growth at the ATPs. Climate variability is not in the control of the project; therefore, the mitigation strategies include utilizing CA and other practices to address these issues.
- Pest and disease infection on the vegetables was also a major challenge in maintaining the technologies at the ATPs.
- The service provision has increased this year but due to the high demand of farmers the service for no-till sowing still remains a main issue to scaling up CA. Several farmers were upset when the service could not be provided on time while another farmer did not have difficulties. Farmers considered it as an unfair and unbalanced process. CESAIN is working with the farmers and technology managers to address these issues and develop a more transparent and equitable approach with the service providers.

8. **Presentations and Publications:**

Journals:

- 1) Dy, K., Ro, S., Roern, S., Ngoun, S., Chea, L.... (December 2020). Genetic variation in agronomic traits and yield performances of tomato (*Solanum lycopersicum*) genotypes in response to heat stress (pp.32-38). Asian Journal of Agricultural and Environmental Safety, 2020(1), Cambodia

- 2) Lam, B., Hong, C., Socheath, O., Yem, S., & Song, S. Detection and management of tomato leaf curl virus (TLCV) by using plant extract species to control disease severity and disease incidence. *Environmental Science and Engineering*. (in review)
- 3) Nut, N., Mihara, M., Jeong, J., Ngo, B., Chan, S., Sigua, G., & Reyes, M. R. (December 2021). Impacts of Land Use-Land Cover Changes on Streamflow and Water Balance of Stung Sangkae Catchment Using SWAT (pp.201-208). *International Journal of Environmental and Rural Development*, 12(2), Japan
- 4) Paul, N., Epper, B. K., Tschopp, C. A., Long, D. J., Tungani, C. T., Burra, D., Hok, L. & Douxchamps, S. (2022). Crop-livestock integration provides opportunities to mitigate environmental trade-offs in transitioning smallholder agricultural systems of the Greater Mekong Subregion. *Agricultural Systems*, 195, 103285.

Presentations and Theses:

- 1) Alrawashdeh, G. S., Lindgren, S., Reyes, M., & Pisey, S. (2022). Developing Youth's Capacities as Active Partners in Achieving Sustainable Global Food Security through Education. *Environmental Sciences Proceedings 15(1)*, 28.
- 2) Chork, R. Effect of Living Mulches and Nitrogen Source Management on Soil Nitrogen in Chili Pepper Production – MS Thesis
- 3) Lam, B. The Efficacy of Plant Extract to Control Tomato Leaf Curl Virus Disease – MS Thesis
- 4) Nai, R. Development of Cold-Chain for Post Harvest Loss Reduction of Chinese Cabbage (*Brassica campestris* L. ssp. *pekinensis*) – MS Thesis
- 5) Ngoun, S. Evaluation of Agronomic Traits and Yield of Tomato Genotypes Under High Temperature – MS Thesis
- 6) Ouk, C., Ro, S., & Tho, K. (March 2021). Effect of Different Mulching Types on Insect and Disease Infestation and Yield of Onions (*Allium Cepa* L.). The 12th International Conference on Environmental and Rural Development (ICERD), Online

Haiti Agricultural University Partnership (HAUP): Center of Excellence on Mitigation, Adaptation, and Resilience to Climate-Change in Haiti (CE MARCH)

1. **Name:** Haiti Agricultural University Partnership (HAUP): Center of Excellence on Mitigation, Adaptation, and Resilience to Climate-Change in Haiti (CE MARCH)
2. **Location:** Haiti
3. **Description:** The Haiti Agricultural University Partnership (HAUP): The CE MARCH initiative was developed to provide training for agricultural professionals and others involved in agriculture, and to train new individuals in agricultural practices. This training will produce agricultural professionals better able to adapt to Haitian crop and animal production systems in a changing climate. They will also be able to understand the role climate plays on Haitian soil resources, water supplies, and their interaction.
4. **Collaborators:** Kansas State University-Sustainable Intensification Innovation Lab (SIIL), the University of Quisqueya, Faculté d'Agronomie et de Médecine Vétérinaire (FAMV), Campus Henri Christophe de Limonade (UEH) (CHCL), Université Chrétienne du Nord d'Haïti (UCNH) (NORD), American University of the Caribbean (AUC), and the University Notre Dame of Haiti (UNDH). These universities represent the south, north and west departments of Haiti.
5. **Achievements:**
 - Four out of the six universities have completed and are operating virtual classrooms. These classrooms are being used for teaching, workshops, and training. The installation of these virtual classrooms allows students from all over Haiti to have an education from universities across the country.
 - A total of 104 students are benefiting from CE MARCH scholarships as they pursue various agricultural degrees at six universities. The students are taking classes and also participating in various CE MARCH ATP research projects.
 - Most of the CE MARCH universities have created active partnerships with NGOs or other commercial entities.
 - The ATPs are beginning to offer trainings and extension programs for farmers. These are designed to help farmers improve crop production and develop climate-smart practices. This is an important implementation step because it is a direct link to building capacity with Haitian farmers.
 - CHCL-Limonade and UCNH have hosted their ATP openings during this reporting year. The openings had participants from the local areas and key stakeholders tour the research areas.
6. **Capacity Building:**
 - Trainings have started at the six universities with students and even smallholder farmers in Haiti. These have provided opportunities for building capacity in the early stages of the project.
 - As of September 2023, CE MARCH is supporting 104 students, both B.S. and M.S. degrees, across the six universities in Haiti.
7. **Lessons Learned:**
 - Communication is key to the success of this initiative, and due to accessibility issues, e-mail is likely not the best method for contact partners.
 - Progress on revenue generating activities is largely stalled until unrest in the country can be alleviated. Safety issues, coupled with fuel shortages, provide extra challenges.
8. **Presentations and Publications:**
 - None to report for FY 2023.

Innovation Research, Extension and Advisory Coordination Hub (iREACH)

1. **Name:** Innovation Research, Extension and Advisory Coordination Hub (iREACH)
2. **Locations:** Asia: Locations will be developed in partnership and collaboration with the respective USAID host country missions; West Africa (WA): Burkina Faso, Ghana, Mali, Niger, and Senegal; East Africa (EA): Locations will be developed in partnership and collaboration with the respective USAID host country missions; and Latin America and/or Caribbean (LAC): Guatemala
3. **Description:** An iREACH in each of these regions will serve as a platform to focus on targeted programs such as climate mitigation, adaptation, resilience and focus on producing nutritious and safe food while sustaining natural resources (climate smart agriculture, CSA). There has been much research, capacity building efforts and extension projects from the multiple United States Government (USG) and other international donors in these regions. Most of these activities are dispersed and not easy to keep track due to involvement of multiple actors and lack of a common platform that brings them together. Therefore, there is need for a central institution, organization or university that coordinates these activities or has the capacity to do so. iREACH's three core objectives are: a) improve coordination, alignment, and integration of relevant activities, b) build human and institutional capacity c) establish agricultural technology parks to showcase proven climate-smart agricultural technologies that will address food and nutritional security and build resilience of systems and people.
4. **Collaborators:** Asia and EA: to be coordinated with key stakeholders in the region. LAC: USAID/Guatemala. WA: West and Central African Council for Agricultural Research and Development (CORAF); National Institute for the Environment and Agricultural Research (INERA); The Fruit and Legumes Regional Center hosted by the Center for National Research on Science and Technologies (IRSAT) – Bobo Dioulasso, Burkina Faso; Council for Scientific and Industrial Research (CSIR); The Roots and Tubers Center hosted by the Crops Research Institute (CRI) – Accra, Ghana; Rural Economy Institute (IER); Rice Regional Center of Specialization hosted by the Regional Center for Agricultural Research (CRRRA) – Niono, Mali; Agricultural Research Council of Niger (INRAN); The Livestock Regional Center – Niamey, Niger; and the Senegalese Institute of Agricultural Research (ISRA); The Dry Cereals Regional Institute of Excellence hosted by the Center for the Improvement of the Adaptation to Drought (CERAAS) – Thies, Senegal; multiple Feed the Future Innovation Labs (e.g. Fish, Food Processing, Legume, Peanut, Poultry); and International Fertilizer Development Center (IFDC).
5. **Achievements:**
 - During the reporting period, four Agricultural Technology Parks (ATP) were successfully established in four countries (Burkina Faso, Mali, Ghana, and Senegal).
 - In terms of coordination, letters of agreement were signed between countries and CORAF to support and guide the establishment of ATPs in target countries. The letters were signed during the second quarter of FY 2023.
 - Country coordination meetings were held for better coordination of activities among the different countries to provide support and guidance for smooth implementation of activities.
 - To showcase the thirty technologies established last year, an open field day was organized and held on October 28, 2022, with the participation of 150 stakeholders.
 - In Ghana, two ATPs were established with the support from CORAF-USAID funded project, PAIRED. An open field day was held for the opening of the ATP in Kumasi on October 7, 2022, with 201 men and 71 women present.

- In Mali, the organization of an open field day was held on October 25, 2022, with 205 stakeholder present, 49 of whom were women.
- An open field day was organized to showcase the technologies established in 2022 in Bambey on October 13, 2022, with 229 stakeholder present.
- Niger has received funding from CORAF-Swiss Cooperation project and World Bank for the ATP this cropping season. The Niger team has started the installation of crops well before the onset of the rainy season.

6. **Capacity Building:**

- An online training session on iREACH data collection tools and use of the digital platform was organized in March 2023, and had the participation of 16 individuals involved in ATP management. Additional training is planned for FY 2024.
- During the Advisory Committee Board meeting held in July 2023, Professor Oludayo Daniel was elected as the Vice Chair of the Advisory Committee.
- All open field days organized in Burkina Faso, Mali, Senegal, and Ghana to showcase technologies had more than 850 agriculture stakeholders including local administrative leaders, policy makers, extension services, farmer organizations, and others.

7. **Lessons Learned:**

- It has become a necessity to strengthen the private sector engagement, which is critical for the establishment of enabling environment for sustainable technology scaling.
- Organizing more than one open field day during the growing season could allow for stakeholders to see the crops in different growing stages, and to have multiple communication activities.

8. **Presentations and Publications:**

- None to report for FY 2023.

VII. Human and Institutional Capacity Development

Short-term Training

The following table reports the human and institutional capacity building efforts from short-term training activities. Participants in the training were producers, government representatives, private sector entities, and civil society members. There were 109 short-term trainings offered to 8,781 individuals (3,183 women, 36%).

Country of Training	Brief Purpose of Training	Who was Trained	Number Trained		
			M	F	Total
Bangladesh	Demonstration on mechanical rice transplanting at Purbadhala, Netrokona	Producers, Government, Private Sector	14	1	15
Bangladesh	Demonstration #1 on mechanical rice transplanting at Sadar, Netrokona	Producers, Government, Private Sector	16	1	17
Bangladesh	Demonstration #2 on mechanical rice transplanting at Sadar, Netrokona	Producers, Government, Private Sector, Civil Society	19	1	20
Bangladesh	Training on seed planter at Betagi, Barguna	Producers, Civil Society	13	0	13
Bangladesh	Mechanic training on seed planters, reapers, and transplanters at Khulna	Producers, Government, Civil Society	24	0	24
Bangladesh	Training on rice transplanter seedling raising at Dumuria, Khulna	Producers, Government, Civil Society	14	0	14
Bangladesh	Demonstration on rice transplanter at Dumuria, Khulna	Producers, Civil Society	12	0	12
Bangladesh	Field Day on combine harvester operation at Purbadhala, Netrokona	Producers, Civil Society	35	0	35
Bangladesh	Grameen mechanics training #1 on combine harvester	Producers, Government, Civil Society	27	0	27
Bangladesh	Grameen mechanics training #2 on combine harvester	Producers, Government, Civil Society	32	0	32
Bangladesh	Entrepreneur farmers training #1 on combine harvester for mechanization	Producers, Civil Society	29	0	29
Bangladesh	Entrepreneur farmers training #2 on combine harvester for mechanization	Producers, Civil Society	29	0	29
Bangladesh	Training on research activities for CA at BARI, Gazipur	Civil Society	21	10	31
Bangladesh	Training on capacity development of CA machineries at BARI, Gazipur	Civil Society	18	14	32

Country of Training	Brief Purpose of Training	Who was Trained	Number Trained		
			M	F	Total
Bangladesh	Seminar on climate smart agriculture and sustainable development goals	Civil Society	68	56	124
Bangladesh	Entrepreneurs' development at farmer's level: combine harvester	Producers	30	0	30
Bangladesh	Training on operation, repair, and maintenance of combine harvester	Producers	25	0	25
Bangladesh	Mechanics training on combine harvester	Private Sector	11	0	11
Bangladesh	Inauguration workshop of technology park	Producers, Civil Society	49	3	52
Bangladesh	Hands-on training on combine harvester	Private Sector	29	0	29
Bangladesh	Women and youth empowerment in agriculture	Civil Society	47	58	105
Bangladesh	Agricultural transformation #1: Role of appropriate scale mechanization and postharvest loss innovations	Producers, Government, Private Sector, Civil Society	104	16	120
Bangladesh	Agricultural transformation #2: Role of appropriate scale mechanization and postharvest loss innovations	Producers, Government, Private Sector, Civil Society	81	15	96
Bangladesh	Field day on rice transplanter	Producers	34	1	35
Bangladesh	Prize awarding ceremony of SAIYN idea competition 2023	Civil Society	48	18	66
Bangladesh	Virtual seminar on AI and computer vision in agricultural application	Civil Society	51	31	82
Bangladesh	Virtual seminar on drying and storage system in USA	Civil Society	41	25	66
Bangladesh	Hands-on training on combine harvester	Producers	30	0	30
Bangladesh	Advanced training #1 on CA and irrigation machineries of BARI	Producers, Civil Society	12	0	12
Bangladesh	Advanced training #2 on CA and irrigation machineries of BARI	Producers, Civil Society	12	0	12
Bangladesh	Advanced training on #3 CA and irrigation machineries of BARI	Producers, Civil Society	12	0	12
Bangladesh	Field day #1 on conservation agriculture and irrigation machineries of BARI	Producers, Civil Society	14	8	22

Country of Training	Brief Purpose of Training	Who was Trained	Number Trained		
			M	F	Total
Bangladesh	Field day #2 on conservation agriculture and irrigation machineries of BARI	Producers, Civil Society	8	14	22
Bangladesh	Field day #3 on conservation agriculture and irrigation machineries of BARI	Producers, Civil Society	15	7	22
Bangladesh	Field day #4 on conservation agriculture and irrigation machineries of BARI	Producers, Civil Society	15	7	22
Bangladesh	Exposure visit to CA park of BARI	Producers, Civil Society	17	1	18
Bangladesh	Advanced training #1 on CA and irrigation machineries of BARI	Producers, Civil Society	12	0	12
Bangladesh	Advanced training #2 on CA and irrigation machineries of BARI	Producers, Civil Society	11	1	12
Bangladesh	Field Day #1 on research activities of conservation agriculture park	Producers, Civil Society	14	5	19
Bangladesh	Field Day #2 on research activities of conservation agriculture park	Producers, Civil Society	24	0	24
Bangladesh	Advanced training #1 on CA and irrigation machineries of BA	Producers, Civil Society	11	1	12
Bangladesh	Advanced training #2 on CA and irrigation machineries of BA	Producers, Civil Society	12	0	12
Bangladesh	Field day #1 on CA and irrigation machineries of BARI	Producers, Civil Society	21	1	22
Bangladesh	Field Day #2 on CA and irrigation machineries of BARI	Producers, Civil Society	22	0	22
Bangladesh	Fertilizer and weed management in rabi crops cultivation under dibbling method	Producers, Civil Society	49	15	64
Bangladesh	Use of oil expeller for oil extraction from sunflower and other oil seeds	Producers	50	6	56
Bangladesh	Refresher training on use of reaper by the service providers	Producers, Private Sector, Civil Society	13	8	21

Country of Training	Brief Purpose of Training	Who was Trained	Number Trained		
			M	F	Total
Bangladesh	Maize and sunflower production by dibbling and traditional method	Producers, Civil Society	186	84	270
Bangladesh	Mechanical harvesting of rice by reaper	Producers, Private Sector, Civil Society	126	40	166
Bangladesh	Mentoring for rice and rabi crops by cluster farmer field school approach	Producers, Government, Civil Society	428	220	648
Bangladesh	Nutritional awareness for mothers and schoolteachers	Producers, Government, Civil Society	0	378	378
Bangladesh	Field and knowledge sharing seminar on the productivity and rice nutrition	Producers, Government, Private Sector, Civil Society	588	433	1021
Bangladesh	Field training and knowledge sharing seminar on the productivity of maize and sunflower	Producers, Government, Private Sector, Civil Society	452	248	700
Bangladesh	Orientation training on the productivity of rice-maize and rice-sunflower cropping patterns in the polder zone	Producers, Civil Society	416	363	779
Bangladesh	Polder water management and sluice gate operation for adoption of improved cropping in polder zone	Producers, Private Sector, Civil Society	340	100	440
Bangladesh	Procedure, fertilizer management and nutrition from climate resilient and nutritious rice and rabi crops	Producers, Private Sector, Civil Society	486	135	621
Bangladesh	Refresher course on trouble shooting of agricultural machineries for local service providers	Producers, Government, Private Sector, Civil Society	63	18	81
Bangladesh	Safe pesticide application in rice and rabi crops	Producers, Government, Civil Society	67	32	99
Bangladesh	Terminal drainage and rat control in rice	Producers, Government, Private Sector, Civil Society	202	97	299
Bangladesh	Visit for capacity building	Civil Society	7	1	8
Burkina Faso	Producer training on ASMC chopper	Producers, Government	83	50	133
Burkina Faso	Craftsman training on how to manufacture ASMC tools	Producers, Government	10	10	20

Country of Training	Brief Purpose of Training	Who was Trained	Number Trained		
			M	F	Total
Burkina Faso	Online session on iREACH data collection tools and the digital platform	Government	16	12	28
Burkina Faso	Manager training for iREACH park	Government	18	12	30
Cambodia	Exchange field visit of farmers in Battambang	Producers, Government, Private Sector, Civil Society	33	18	51
Cambodia	Field visit of Dr. Ted Kornecki and stakeholders in Battambang, Cambodia	Producers, Government, Private Sector, Civil Society	25	9	34
Cambodia	Workshop on fundamental CA production system small machinery manufacturing design	Government, Private Sector, Civil Society	34	10	44
Cambodia	Training on experimental design for performance testing of small machinery	Government, Private Sector, Civil Society	14	6	20
Cambodia	Field showcase #1 of land leveler to farmers and service provider at Pichangva village	Producers, Government, Private Sector, Civil Society	25	13	38
Cambodia	Field showcase #2 of land leveler to farmers and service provider at Songha village	Producers, Government, Private Sector, Civil Society	19	16	35
Cambodia	Field trip of students and lecturers from FABI to Battambang and Siem Reap	Producers, Private Sector, Civil Society	26	10	36
Cambodia and USA	Open system agricultural machinery design and manufacturing	Civil Society	16	3	19
Cambodia	Promotion #1 of CA practices to farmers	Producers	12	9	21
Cambodia	Promotion of CA practices to rice farmers	Producers	3	6	9
Cambodia	Promotion #2 of CA practices to farmers	Producers	16	7	23
Cambodia	Promotion #3 of CA practices to farmers	Producers	5	7	12
Cambodia	Promotion #4 of CA practices to farmers	Producers, Government	6	22	28
Cambodia	Promotion #5 of CA practices to farmers	Producers	9	18	27

Country of Training	Brief Purpose of Training	Who was Trained	Number Trained		
			M	F	Total
Cambodia	Promotion #6 of CA practices to farmers	Producers	2	15	17
Cambodia	Promotion #7 of CA practices to farmers	Producers	15	15	30
Cambodia	Promotion #8 of CA practices to farmers	Producers	15	15	30
Cambodia	Promotion #9 of CA practices to farmers	Producers	11	19	30
Cambodia	Small scale on-farm demo of seed broadcaster	Producer, Government	17	10	27
Cambodia	Promotional event for no-till planter and service provisions	Producers, Government, Private Sector, Civil Society	24	12	36
Cambodia	Commercial scale event on cover crop	Producer, Government	20	45	65
Cambodia	Commercial scale event on cover crop	Producers, Government, Private Sector	24	41	65
Cambodia	Cardec conservation agriculture showcase	Producers, Civil Society	15	4	19
Cambodia	Training on cover crop establishment after rice	Producers, Private Sector, Civil Society	21	2	23
Cambodia	Harvesting training at Chirouk village	Producers, Government, Civil Society	19	9	28
Cambodia	Harvesting training event #1 at Sangha village	Producers, Government, Civil Society	34	17	51
Cambodia	Harvesting training event #2 at Sangha village	Producers, Government, Private Sector, Civil Society	23	11	34
Cambodia	Harvesting training event at Damnank Dangkor village	Producers, Government, Private Sector, Civil Society	28	17	45
Cambodia	Cover crop research training and tour of research sites to Rottanak Mondol and Banan district	Producers, Government, Private Sector, Civil Society	26	9	35
Cambodia	Training #1 on Grafted Tomato and Preparation Before Grafting	Producers, Government	6	17	23

Country of Training	Brief Purpose of Training	Who was Trained	Number Trained		
			M	F	Total
Cambodia	Training #2 on Grafted Tomato and Preparation Before Grafting	Producers, Government	11	8	19
Cambodia	Training #3 on Grafted Tomato and Preparation Before Grafting	Producers, Civil Society	8	9	17
Cambodia	Training on Grafted Tomato Plant for PDAFF	Government, Civil Society	12	8	20
Cambodia	Life skills training- general conservation agriculture practices	Civil Society	23	31	54
Cambodia	Training at Bright Hope Institute on wild food plant, Tomato grafting, conservation agriculture	Civil Society	8	3	11
Cambodia	National Meanchey University workshop: tomato grafting, wild food plant propagation.	Civil Society	12	10	22
Cambodia	Capacity building in Agriculture in high schools	Civil Society	15	13	28
Cambodia	Collaborations with Farmer to Farmer	Civil Society	26	21	47
Cambodia	Tomato grafting workshop and competition Battambang	Civil Society	35	35	70
Senegal	Training on land-potential knowledge system and Shiny application	Government, Civil Society	20	6	26
Senegal	SI of Agriculture for a Resilient Food System Symposium	Civil Society	70	50	120
Senegal	Training #1 of production of seeds and millets varieties	Producers	16	10	26
Senegal	Training #2 of production of seeds and millets varieties	Producers	16	10	26
Total	109 total trainings were held during FY 2023		5,598 (64%)	3,183 (36%)	8,781

Long-term Training

The following table reports all U.S. citizens/permanent residents and third country nationals that are currently receiving SILL funds through consortia, research subaward projects, associate award, or buy-in awards. The total number of degree-seeking students is 65 with 40% females. There are 28 Ph.D. students (29% female), 33 M.S. students (42% female), and 4 B.S. students (100% female).

Coded Name	Sex	University	Degree	Major	Program End Date (year/month)	Degree Granted (Y/N)	Home Country
I	F	Bangladesh Agricultural University	Ph.D.	Agricultural Economics	2023, August	Y	Bangladesh
36	M	Bangladesh Agricultural University	Ph.D.	Water Management	2023, December	N	Bangladesh
32	M	Bangladesh Agricultural University	Ph.D.	Agricultural Engineering	2023, June	Y	Bangladesh
53	M	Bangladesh Agricultural University	Ph.D.	Agricultural Engineering	2023, June	Y	Bangladesh
55	M	Bangladesh Agricultural University	M.S.	Agricultural Engineering	2022, December	Y	Bangladesh
2	M	Bangladesh Agricultural University	M.S.	Agricultural Engineering	2022, December	Y	Bangladesh
79	M	Bangladesh Agricultural University	M.S.	Farm Power and Machinery	2022, December	Y	Bangladesh
22	M	Bangladesh Agricultural University	M.S.	Agricultural Engineering	2022, December	Y	Bangladesh
94	M	Bangladesh Agricultural University	M.S.	Farm Power and Machinery	2023, September	N	Bangladesh
92	F	Bangladesh Agricultural University	M.S.	Gender Research	2023, September	N	Bangladesh
93	F	Bangladesh Agricultural University	M.S.	Agricultural Economics	2023, September	N	Bangladesh
163	M	Bangladesh Agricultural University	M.S.	Farm Power and Machinery	2022, December	N	Bangladesh
165	M	Bangladesh Agricultural University	M.S.	Farm Power and Machinery	2023, September	N	Bangladesh
159	M	University of Norbert Zongo	Ph.D.	Agronomy	2023, December	N	Burkina Faso
162	F	University Joseph KI-Zebro	Ph.D.	Agronomy	2023, February	Y	Burkina Faso

Coded Name	Sex	University	Degree	Major	Program End Date (year/month)	Degree Granted (Y/N)	Home Country
98	F	University Saint Thomas d'Aquin	B.S.	Agronomy	2023, December	N	Burkina Faso
161	M	University Joseph KI-ZERBO	Ph.D.	Agronomy	2023, November	N	Burkina Faso
99	F	University Saint Thomas d'Aquin	B.S.	Agronomy	2023, December	N	Burkina Faso
100	M	University of Nazi Boni	Ph.D.	Animal Science	2025, July	N	Burkina Faso
101	F	University of Nazi Boni	M.S.	Rural Development	2023, February	Y	Burkina Faso
102	M	University of Nazi Boni	M.S.	Nutrition	2023, November	N	Burkina Faso
166	F	University of Nazi Boni	M.S.	Agriculture	2024, July	N	Burkina Faso
157	M	Royal University of Agriculture	M.S.	Crop Science	2023, December	N	Cambodia
103	F	Royal University of Agriculture	M.S.	Agricultural Extension	2023, December	N	Cambodia
95	M	National University of Battambang	M.S.	Sustainable Agriculture	2022, December	Y	Cambodia
97	F	Royal University of Agriculture	M.S.	Agricultural Sciences	2023, December	N	Cambodia
104	M	National University of Battambang	M.S.	Soil Science	2023, June	Y	Cambodia
96	F	National University of Battambang	M.S.	Sustainable Agriculture	2022, December	Y	Cambodia
47	M	National University of Battambang	M.S.	Sustainable Agriculture	2024, August	N	Cambodia
167	M	National University of Battambang	M.S.	Sustainable Agriculture	2024, August	N	Cambodia
168	M	National University of Battambang	M.S.	Sustainable Agriculture	2024, August	N	Cambodia
169	F	National University of Battambang	M.S.	Sustainable Agriculture	2024, August	N	Cambodia
82	F	Royal University of Agriculture	M.S.	Public Administration	2022, December	Y	Cambodia
130	F	University Sains Malaysia	M.S.	Aquatic Biology	2024, February	N	Cambodia
7	M	Royal University of Agriculture	M.S.	Crop Sciences	2023, August	Y	Cambodia
132	M	Kasetsart University	Ph.D.	Agricultural Sciences (Agricultural Extension and Communication)	2024, December	N	Cambodia
133	M	Kasetsart University	Ph.D.	Agricultural Sciences (Agricultural Extension and Communication)	2024, December	N	Cambodia
134	F	Royal University of Agriculture	Ph.D.	Agricultural Sciences (Agricultural Extension and Communication)	2025, July	N	Cambodia

Coded Name	Sex	University	Degree	Major	Program End Date (year/month)	Degree Granted (Y/N)	Home Country
170	M	Royal University of Agriculture	M.S.	Development Studies	2024, January	N	Cambodia
171	F	Royal University of Agriculture	M.S.	Food Science and Technology	2023, December	N	Cambodia
172	F	Royal University of Agriculture	Ph.D.	Agricultural Sciences	2023, December	N	Cambodia
173	M	University of Montpellier	Ph.D.	Agricultural and Environmental Science	2024, December	N	Cambodia
174	F	Royal University of Agriculture	M.S.	Development Studies	2024, September	N	Cambodia
158	M	Michigan State University	Ph.D.	Agriculture, Food, and Resource Economics	2025, May	N	Columbia
175	F	Michigan State University	B.S.	Geography, Environment, and Society	2023, August	N	Iran
178	M	Michigan State University	Ph.D.	Biosystems and Agricultural Engineering	2023, September	N	Iran
105	F	Michigan State University	M.S.	Biosystems and Agricultural Engineering	2023, August	Y	Malawi
106	F	Michigan State University	M.S.	Biosystems and Agricultural Engineering	2023, April	Y	Malawi
180	M	Michigan State University	Ph.D.	Computer Science / Biosystems and Agricultural Engineering	2023, December	N	Pakistan
85	M	University of Thies	Ph.D.	Animal Science	2023, December	N	Senegal
107	F	University of Thies	B.S.	Agricultural Engineering	2023, June	Y	Senegal
108	M	University of Thies	M.S.	Forage Biomass Production	2023, January	Y	Senegal
110	M	University of Gaston Berger, St. Louis	Ph.D.	Agricultural Mechanization	2023, April	Y	Senegal
111	M	University of Dakar	M.S.	Agricultural Mechanization	2023, March	Y	Senegal
113	M	Michigan State University	Ph.D.	Biosystems and Agricultural Engineering/Computer Science	2023, December	N	Togo
114	F	University of Minnesota	Ph.D.	Geography, Environment, and Society	2023, December	N	United States
116	F	University of Colorado Boulder	Ph.D.	Environmental Studies	2023, May	Y	United States
117	M	Michigan State University	M.S.	Biosystems and Agricultural Engineering	2023, December	N	United States
118	F	Kansas State University	Ph.D.	Agronomy	2023, April	Y	United States
164	F	University of Tennessee	Ph.D.	Biosystems Engineering and Soil Science	2023, August	Y	United States
176	M	University of Minnesota	Ph.D.	Earth Science / Biogeoscience	2023, December	N	United States

Coded Name	Sex	University	Degree	Major	Program End Date (year/month)	Degree Granted (Y/N)	Home Country
177	M	Kansas State University	Ph.D.	Agronomy	2025, August	N	United States
179	M	University of Minnesota	Ph.D.	Computer Science	2023, December	N	United States
181	M	University of Minnesota	Ph.D.	Bioproducts and Biosystem Science, Engineering and Management	2023, December	N	United States
182	M	University of Minnesota	Ph.D.	Bioproducts and Biosystem Science, Engineering and Management	2023, December	N	United States

Institutional Development

CE SAIN Institutional Development: The CE SAIN 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 eight Agricultural 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); Provincial Department of Agriculture, Forestry and Fisheries (PDAFF); Department of Agricultural Engineering (DAEng); Royal University of Agriculture – Phnom Penh; University of Battambang; and multiple Feed the Future Innovation Labs (e.g., Fish Innovation Lab, Food Safety Innovation Lab, and SIIL); 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 have and will continue to collaborate with national and regional organizations, specifically as the iREACH initiative has matured and is being more widely implemented.

Partnerships: Senegal – Mathematica (project on Sustainable Agricultural Decision Tools, AICCRA (Accelerating Impacts of CGIAR Climate Research for Africa) 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 SILL supported the creation, testing and scaling of 26 technologies during FY 2023, three of which were made available for uptake (Phase 3) and 14 that have already shown adoption by the public and private sectors (Phase 4). During this reporting period, SILL's project partners have worked with numerous organizations, institutions, farming groups and local artisans to create, scale up, and extend their various innovations.

Steps Taken:

- ASMC continues to collaborate with the private sector motor companies, the Department of Agricultural Extension, the BARI, and the BAU to create, fund, and extend their rice harvesters and transplanters. They also work with CIRAD, Smart-Agro, and Swisscontact to support scale-up.
- The Polder project continues to work with local universities, the IARC and NARES to create an innovative cropping pattern for more sustainable rice production in the polder region. Using virtual field days, trainings, and workshops, the project was able to refine the planting techniques for wider uptake.

Partnerships:

- ASMC: Bangladesh Agricultural University (BAU), ACI Motors Ltd., Metal Pvt Ltd., Bangladesh Agricultural Research Institute (BARI), Bangladesh Rice Research Institute (BRRI), Department of Farm Power and Machinery, Department of Agriculture Extension (DAE) subsidy program, CASC/DALRM, CIRAD, Smart-Agro, Swisscontact, RUA, International Agricultural Research Center (IARC)
- Pathways of Scaling Agricultural Innovations for Sustainable Intensification in the Polders: BARC, International Rice Research Institute (IRRI), local public universities
- Improving Food and Nutrition in Senegal and Niger: ANCAR, Local Food Processing Institute, ISRA – CERAAS, Peace Corps, ENSA, Agropastoralists of the Senegal peanut basin

Technology Ready to Scale (Phase 3):

- Pathways of Scaling Agricultural Innovations for Sustainable Intensification in the Polders: 1) Rice-Maize Cropping System in Polders; 2) Rice-Sunflower Cropping System; 3) Agricultural Mechanization in Harvesting Paddy by Women and Youth Agri-entrepreneurs

Technologies Transferred (Phase 4):

- ASMC – Bangladesh: 1) Combine Harvester; 2) Rice Reaper; 3) Rice Transplanter; 4) Two-Wheel Tractor Based Seed Planter
- ASMC – Burkina Faso: 1) Mechanized Maize Planting System with ASMC Planter; 2) ASMC Forage Chopper
- ASMC – Cambodia: 1) No-Till Planter; 2) Seed Broadcaster; 3) Land Leveler; 4) Cover Cropping
- ASMC – Senegal: 1) Biomass Chopper
- Improving Food and Nutrition Security in Senegal and Niger: 1) Dual-Purpose Pearl Millet Grain and Fodder Biomass Production; 2) Enriched Millet Flour for Pregnant Women and 3) Undernourished Children and Pearl Millet Seed Sub-Residues for Chicken Feed-Making; Improved Dual-Purpose Pearl Millet Stover for Livestock Feed

IX. Environmental Management and Mitigation Plan (EMMP)

An annual environmental mitigation activity review was conducted by the SILL management entity across all subawards. The review entailed an evaluation of all activities outlined in the EMMP. Given the previous year's focus on 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.

In addition, the Piestar DPx system, which the SILL utilizes for reporting and project monitoring, underwent significant revisions of the EMMP module to support SILL'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 is also incorporated into the DPx system to ensure that project monitoring is streamlined and to optimize knowledge sharing within the SILL management entity.

X. Open Data Management Plan

The SILL management entity established the SILL Dataverse to store and curate all SILL subaward datasets and serve as a data repository and access hub for the SI community in general. The complete datasets from all projects can be found in the SILL's Dataverse (<https://dataverse.harvard.edu/dataverse/SILL>), hosted by Harvard Dataverse.

Each complete dataset is 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).

Finally, all previous SILL annual reports (2015-2022) have been uploaded into the USAID Development Experience Clearinghouse (DEC), the SILL website, and are available to the public.

XI. Governance and Management Entity Information

Regional and Country Coordinator Activity

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

a) **Burkina Faso:** Dr. Hamidou Traoré, the SILL Burkina Faso Coordinator and Director General of INERA, works with graduate students, research scientists, and government delegates to move the food and agricultural security agenda forward. Here are some highlights from his work in FY 2023:

- Many farmers visited the technology park of Farako-Ba and are willing to adopt the technologies displayed there like orange-fleshed sweet potato, soybean, etc., if the cuttings and seeds are made available.
- The private sector including agro-dealers, traders, and processors were very interested in the activities during the Farako-Ba open day on October 28, 2022.
- The majority of farmers who were trained were women.

Publications

- 1) Sanna, S. A., Ouedraogo, M., Yonli, D., Nikiema, P., Traore, H..... Effect of the cereal-legume association, water management and soil fertility for improving agricultural productivity in eastern Burkina Faso. *Science and Technology, Natural and Applied Sciences Series*.
- 2) Koumbem, M., Pale, S., Hien, E., Yonli, D., Traore, H..... Assessing the effects of tillage, cropping systems with soil amendments on soil phytochemical properties in the Centre-Western Region of Burkina Faso. *World Journal of Agricultural Sciences*.
- 3) Koumbem, M., Palé, S., Hien, E., Yonli, D., Traore, H..... Effects of tillage and organo-mineral fertilization on soil humidity and chlorophyll assimilation of sorghum in intercropping with cowpea. *International Journal of Biological and Chemical Science*.

Other

- 1) Sanna, S. A. Effects of cropping systems on soil quality, weed flora and agricultural productivity in the Sudano-Sahelian zone of Burkina Faso. *International Journal of Biological and Chemical Science*

b) **Cambodia:** Dr. Manny Reyes continues his work as the SILL Country Coordinator for SILL, working primarily with CE SAIN and the ASMC-Cambodia teams, but also continuing SILL'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 2023:

- The Government of Bangladesh has committed to continue funding for at least 50% subsidies for Combine Harvesters for smallholder farmers.
- The Bangladesh team has established single-shed service providers to scale up the mechanization technologies through individual farmers and with the assistance of the private sector.
- Cambodia experienced difficulties in receiving funds. Because of this, the work was affected. Open Systems Agricultural Machinery Manufacturing training by Dr. Ted Kornecki from USDA was successful. This focused mainly on Conservation Agriculture machineries designed and tested by the USDA National Soil Dynamics Lab for two-wheel tractors.
- ASMC-Cambodia recruited and trained three interns to be specialists and CASI extension and consultation services. In addition, several service workshops, demonstrations, field showcases, and demand creation meetings were conducted to promote four technologies that were identified with more than 10,000 participants,

- In Cambodia, over 1,200 hectares of land and 449 household have been impacted by the no-till planter, land leveler, and cover crops.
- c) **Senegal:** Dr. Aliou Faye continues his work as the West Africa Regional Coordinator. Here are a few highlights from FY 2023:
- Organization of the Open Days of the Agricultural Technology Parks on for iREACH during October 2022.
 - Shared innovations and improved millet and cowpea seeds with the West Africa Technology Parks in Niger, Burkina Fast, Mali, and Ghana.

XII. Other Topics

Gender Integration Highlights:

During the FY 2023 reporting period, the SIIIL requested the consortia and subawards to provide additional information on how their projects were integrating gender into their research. All of them had actively integrated gender into their programs. Below are the highlights from the projects:

The ASMIH – Cambodia project completed a field survey to understand the role of women farmers and service providers in a household's decision to continue to implement Conservation Agriculture, along with CASI machinery use, and to find out whether there is any difference between men and women attending the training programs. From the research findings, a training was provided to women farmers in Battambang province by Gender Specialist, Maria Jones, from the University of Illinois at Urbana-Champaign and the local gender and youth coordinator. The technical report is available upon request.

The Bangladesh Polder project had a total of 2,177 (39% of the total) female individuals that participated in capacity building on different aspects of agricultural development, nutrition, and mechanization in the polder zone. Among the participants, 207 women directly engaged in the demonstration of improved cropping practices and agri-mechanization services in different learning hubs of the polder zone. Three women service providers were directly engaged in harvesting paddy by reapers and earned a total of \$169 to \$882 USD during the reporting period, which they spent on the most productive and income-generating purposes.

Nutrition Integration Highlights:

During the FY 2023 reporting period, the SIIIL also requested the consortia and subawards to provide additional information on how their projects had addressed nutrition as a cross-cutting theme in their research activities. Below are the highlights reported from the projects:

The S3-Cambodia project worked with a variety of schools and community-based organizations to help scale SI technologies. As part of this, they worked with a local organization called Partners for Rural Development. This organization manages a program for girls that teaches a variety of topics, including agriculture. The project was able to present to the girls in the program agribusiness training, conservation agriculture approaches to vegetable gardens, as well as the value of Wild Food Plants in a garden.

The Bangladesh polder project continued its regular Nutritional Awareness Program involving the mothers of school children and female schoolteachers, in which 378 women participated during this reporting period. The farming community was also included in the Nutritional Awareness Program while empowering them on the production of zinc-enriched rice, maize, and sunflower. A total of 1,105 men and women participated in the training events.

XIII. Issues

Challenges related to implementation in Haiti

Due to the on-going unrest in the country, there continues to be major concerns for safety, especially in the Port-au-Prince area. Despite these challenges, CE MARCH partners have still managed to make progress on their activities with the exception of Quisqueya University, which is located in Port-au-Prince. As a result of accessibility issues, means of communication with the partner universities have proven to be difficult and it has taken patience to work through these issues. The project director, Elizabeth Guertal, and SILL director, Vara Prasad, have been able to successfully conduct site visits to Haiti and attend the launching events of two of the Agricultural Technology Parks during this reporting period. The ability to travel and safety issues will continue to be monitored.

XIV. Future Directions and Activities

SIIL Management Entity

SIIL's three focus country projects (Bangladesh, Cambodia, and Senegal) and the ASMC consortium requested a no-cost extension to complete their research activities by September 30, 2023. Therefore, the project researchers, leaders, and SIIL Management Entity will close out these activities during the first 90 days of FY 2024. The Digital Tools, Geospatial and Farming Systems Consortium (DGFSC) was also granted a no-cost extension for their current activities which were completed on September 30, 2023.

Given the nature and value of the DGFSC activities, SIIL will provide funding to implement an additional modeling activities and outreach under a larger initiative, known as Digital Ag Institute ([ID3A](#)) a new institute established at KSU, during FY 2024. This project will conduct the following activities: 1) Soil mapping of Bangladesh, Cambodia, and Senegal; 2) Open databases on fertilizer response to crops and on intercropping suitability assessment; 3) Crop mapping and labels for Senegal; 4) Data Generation for Crop Modeling and data Transferring in SIAF tool for Bangladesh; 5) Characterization of crop intensification (summer crops vs fallow areas) for Bangladesh; 6) Development of new research (searchable database) for Cambodia – CESAIN; 7) Modeling the impacts of drought and flood (climate shocks) using historical weather data; 8) Development of a Data-driven Crop Model for Yield Prediction in Senegal; 9) Map the suitability and impact of agriculture related climate solutions; 10) Map natural capital; 11) Maps socio-economic context, and; 12) Map hotspots of opportunities where agricultural strategies work best.

In FY 2024, SIIL will contract with a communication entity to capture the decade of research accomplishments and highlight the importance and impact of the SIIL portfolio. This will be produced in a variety of output materials including videos, interviews, feature stories, and the final 10-year report.

The SIIL will host three face-to-face events: 1) Sustainable Intensification (SI) Thought Leadership Summit in February 2024; 2) SIIL's final annual meeting in Phnom Penh, Cambodia in June 2023, and; 3) Leadership Academy in Somone, Senegal in July 2024. These events are to share knowledge, gain additional insights, showcase successes, and strengthen our capacity building efforts related to the SIIL portfolio. Participants from all projects, consortia, external advisory board members, key partners along with USAID delegates are invited to the annual meeting for cross-collaboration, and to observe the results, impacts, outputs, and outcomes from each project and consortia of the SIIL, while the other events will be by invitation.

The SIIL will continue to build their presence in Latin American and the Caribbean by implementing the HAUP-CEMARCH Associate Award in Haiti and strengthen their partnership with the USAID Guatemala Mission to build on our successes of replicating innovation, research, extension, and advisory coordination center/hub. SIIL is also exploring the possibilities to implement similar approaches as CEMARCH in Ethiopia.

iREACH Implementation and Expansion

The goal of this initiative is to create regional innovation, research, extension, and advisory coordination hubs (iREACH) in the Feed the Future target and resilience focus region, and countries that will foster private sector innovation, agricultural research, education, extension and training, and public-sector capacity building through improved collaboration, communication and knowledge sharing on aspects related to CSA (climate smart agriculture) and food and nutritional security in the various regions (Asia, West Africa, East Africa, and Latin America and the Caribbean). In FY 2024, the SIIL will continue to support and strengthen the Activity Tracker for all 20 of the Feed the Future target countries, as well as the 21 Innovation Labs and the Accelerated Innovation Delivery Initiative (AID-I) activities in the East and Southern Africa and the Great Lakes Highlands.

iREACH will also support the Innovation Lab community by providing administrative and program support to help manage the IL portfolio; liaison to identify, build, and strengthen IL collaboration and engagement with current and new IL partners; provide financial support for open access publication costs post-IL awards; and plan, organize, and pay for IL annual meetings, IL Partner Meetings, and other convenings and/or events as appropriate.

CE SAIN Institutionalization at the Royal University of Agriculture

The Center for Sustainable Agricultural Intensification and Nutrition (CE SAIN) is currently funded by SILL and housed at the Royal University of Agriculture in Cambodia and has seven Agricultural Technology Parks located around the country. SILL will continue to support CE SAIN's efforts to be institutionalized into the RUA administrative structure. The goal is for the institutionalization of CE SAIN at RUA to be made official during the upcoming FY 2024 year. In addition, CE SAIN's funding will be merged into the iREACH Associate Award to continue funding until September 23, 2026. This transition will strengthen regional activities and outreach and streamline funding. The CE SAIN and iREACH share similar goals and objectives which will support these initiatives in achieving their goals in advancing the coordination and communication as well as strengthening human and institution capacity and providing agriculture technology parks to showcase promising innovations and technologies in Asia, specifically Cambodia.

XV. Appendices

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

Consortiums:

Title: Appropriate Scale Mechanization Consortium – Phase II

Awarded institution: University of Illinois at Urbana-Champaign

Dates: July 1, 2020 - September 30, 2023

Current year funding: \$0

Total funding: \$2,249,991

Title: Digital and Geospatial Tools Consortium

Awarded institution: Kansas State University

Dates: July 1, 2020 - September 30, 2023

Current year funding: \$1,000,000

Total funding: \$3,000,000

Focus Country Projects (Bangladesh, Cambodia, Senegal & Niger):

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 - September 30, 2023

Current year funding: \$24,643

Total funding: \$797,327

Title: Cambodia: S3 Scaling Suitable Sustainable Technologies

Awarded institution: University of Tennessee

Dates: July 1, 2020 - September 30, 2023

Current year funding: \$0

Total funding: \$750,000

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 - September 30, 2023

Current year funding: \$226,144

Total funding: \$749,999

Initiatives and Associate Awards:

Title: Center of Excellence on Sustainable Agricultural Intensification and Nutrition (CE SAIN) in Cambodia

Awarded institution: Royal University of Agriculture

Dates: July 1, 2016 – September 30, 2026

Current year funding: \$1,944,813

Total funding: \$5,206,489

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

Awarded institution: Kansas State University

Dates: September 24, 2021 – September 23, 2026

Current year funding: \$800,000

Total funding: \$2,691,184

Title: Haiti Agricultural University Partnership (HAUP): Center of Excellence on Mitigation, Adaptation, and Resilience to Climate-Change in Haiti (CE MARCH)

Awarded institution: Kansas State University

Dates: September 30, 2021 – September 29, 2026

Current year funding: \$0

Total funding: \$4,500,000

Title: Economic Impact of Improved Bean Varieties in Central America and USA

Awarded institution: Michigan State University and International Center for Tropical Agriculture (CIAT)

Dates: January 1, 2021 – June 30, 2023

Current year funding: \$39,669

Total funding: \$165,174

SUCCESS STORIES

Success Story #1: The Future of Food Security Depends on Rural Youth



Students plant seed in the polders of Bangladesh to help learn the significance of agriculture.

The youth can be more easily attracted to agriculture when these obstacles are minimized, and resources are made available to them. Having rights and access to land may also help in attracting them to agriculture. With farm mechanization and technological advancement taking place rapidly in the agricultural sector and with the pace of modernization, all these require more involvement of the youth who have the potential to rapidly learn and take advantage of these changes.

Agriculture is no longer a subsistence activity; it is a commercial enterprise and has great prospects. However, societal negligence of agriculture as a profession and profit maximization aspirations from other white-collar jobs are equally responsible for diverting youth from agriculture.

Therefore, the attitude of youth towards agriculture needs to be changed through attractive agricultural education, extension services, training, workshops, and the introduction of technologies. This way, the youth can obtain hands-on information on agricultural practices that best suit a particular region and geographical condition.

Additionally, factors such as gender discrimination should be eliminated to enhance the acceptability of agriculture as a profession among both male and female young people. They should also be provided with adequate credit with flexible terms and conditions so that they can be willing to start agricultural entrepreneurship in rural areas. This may further help them change their intention of migrating to the city, improve their self-esteem, and feel that they can make a living in a rural setting.

Moreover, a significant social recognition of agriculture as a prestigious profession may bring youth back to the farm. The rural youth, a crucial factor in food security, should be the target group that can uphold the adoption of new technologies to maintain sustainable production and agricultural practices in the polder of Bangladesh.

Hopefully, the findings of this study will help development practitioners, policymakers, youth leaders and associates, and producers' organizations find a workable solution that can motivate the youth to regard agriculture as a respectful, remunerative, and potential occupation in Bangladesh.

The time is to act now if we have an adequate number of farmers to feed the future generation of the country.

Success Story #2: Preserving the Forest in Northern Cambodia

Cambodia has recently faced significant challenges in preserving its natural environment, including the forests in the northern region. In the last decade Cambodia has lost over 60% of its tree cover with over 6,000 hectares being lost in the north. These forests are of great importance to indigenous Kuy communities as it holds their traditional knowledge of land use, economic opportunities, and natural resources. Over the years, the forest's health has declined, due to land use change and deforestation. This leads to the loss of Indigenous knowledge which has impacted both the well-being of the local people and the preservation of their homeland.



Rachakny is a third-year undergraduate student at the National University of Battambang and is committed to the conservation of Indigenous knowledge in the Prey Lang Forest. She hails from the Kuy community in Krong Stung Treng, a region within the Prey Lang Forest, where the Indigenous Kuy people have a long-standing connection to Cambodia. Raised in a family deeply involved in protecting the forest, Rachakny has been surrounded by those who cherish the traditional practices of preserving the Prey Lang's biodiversity and sustainable cultivation.

Rachakny's journey in preserving Indigenous knowledge formally began after high school when she served as a research assistant, engaging with local communities to understand their relationship with the forest and their concerns with deforestation. Her dedication and the quality of her work caught the attention of both international and local scholars. With the support and leadership of the United States Agency for International Development (USAID) and the Feed the Future Innovation Lab for Sustainable Intensification, or SIIL, at Kansas State University Rachakny received a scholarship to further her studies and continue her mission.

"I have always grown-up learning and loving the forest and my goal through my research work is to show others in my community the benefits of not only preserving the forest but using the wild food plants that grow within it. These plants are high in nutrition and many also have medicinal properties," Rachakny states. "I am so thankful that I got to grow up knowledgeable of my ancestors and how they used and protected the land. As the forest is taken so is a part of our family history."



Her late father instilled in her an appreciation and value of the forest, plants, and Indigenous knowledge along with a desire to give back to her community. Through her work at her university, she has recently had the opportunity to bring propagated cuttings of native trees, shrubs, vines, and other plants from her nursery in Battambang back to the Indigenous communities who live in the Prey Lang Forest. These cuttings will be used to start reforesting the land while creating food forests for the locals to utilize. The communities will be able to reach the edible parts of the roots, flowers, and leaves. Schools can

educate the students on the importance of biodiversity and agriculture, and local merchants are trained on how to propagate the plants themselves for resell and economic growth.

“I am so pleased that my education has given me these opportunities to give back to my community and teach the importance of wild food plants. In the future I intend to bring my propagated cuttings to more communities in Cambodia who are facing deforestation and loss of Indigenous knowledge.”

Rachakny sees her work as a continuation of her family's legacy as she plans to stay dedicated to restoring and maintaining the health of the forest and investing in those who share her commitment.

Success Story #3: Importance of Updated Farming Methods for Productions in Senegal

Mr. Douglas Zehr, a professor at William Penn University and a long-time supporter of the efforts United States Agency for International Development (USAID) and the Feed the Future Innovation Lab for Sustainable Intensification (SILL), at Kansas State University in Senegal had the chance to visit the Improving Food and Nutrition Security of Smallholder Agro-pastoral Farming Systems by Integrating Crop-livestock-human Nutrition in Senegal and Niger project to witness the positive changes that were being made. The trip began on Monday April 24, 2023, where Zehr visited the offices of L'Institut Sénégalais de Recherches Agricoles (ISRA – Senegalese Institute for Agricultural Research) and the Centre d'étude régional pour l'amélioration de l'adaptation à la sécheresse (CERAAS - Regional Study Centre for Improving Adaptation to Drought).

The research station in Bambey has a long history that began in the French colonial era. Research conducted here has impacted much of West Africa including their agricultural sector. The surrounding area is considered the groundnut basin of Senegal and is also known for producing millet, another significant crop for the region. The land is flat and arid, and grain crops are grown during the months of July to September when there is adequate rainfall. The World Bank and USAID cooperate with ISRA along with universities around the world to assisted in building a two-wheel tractor and two-row planter that is pulled with the power ox which have greatly contributed to productivity of Senegalese producers.

Later in the week, Zehr presented the goals for the Power Ox training with three components: classroom, workshop, and field. He explained the three main ways to control weeds mechanically which is to cut, cover, or uproot. Zehr reiterated the importance of killing weeds in the white thread stage and introduced the Tilmor tools available for the task. A very important discussion followed on farm economics that completed the day. One interesting comment made by the farmer/ISRA technician was that he lost land when a highway was built through his farm, however his yields improved. He explained that he had more time to tend the crop and remove weeds since his land area had decreased. The consensus of the group was that weeding is very time-consuming and requires lots of labor but it is worth it for the long run to sustain a successful operation.



Mr. Zehr was giving his presentation over updated weeding efforts.

As the visit concluded the importance of early, frequent weeding was re-emphasized, which will increase crop yields compared to traditional methods. Farmers who practice shallow, precision weeding in Europe and North America know the benefits well. Their objective is to reduce the weed seedbank in the soil by never allowing weeds to produce seed. This makes weeding easier in each subsequent year. Shallow cultivation minimizes soil disturbance, conserves moisture, and brings fewer weeds to the surface than traditional mechanical methods that use high-crown sweeps. Appropriately scaled machines can be economical when the large amount of hand labor required for weeding is considered.