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

FY2024 ANNUAL REPORT

FEED THE FUTURE INNOVATION LAB FOR FOOD SAFETY

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PURDUE UNIVERSITY

Cornell University

Feed the Future
Innovation Lab for Food Safety (FSIL)

Annual Report
October 1, 2023 - September 30, 2024

This report is made possible by the generous support of the American people through the United States Agency for International Development (USAID). The contents are the responsibility of the authors and do not necessarily reflect the views of USAID or the United States Government. Program activities are funded by USAID under Cooperative Agreement No. 7200AA19LE00003.

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Management Entity

The Feed the Future Innovation Lab for Food Safety (FSIL) is jointly managed by Purdue and Cornell Universities. The management entity (ME) provides technical leadership that guides the United States Agency for International Development (USAID) food safety research agenda while ensuring effective management and implementation of all activities within the FSIL portfolio. FSIL's ME and Technical Experts leverage extensive experience in international food safety research, education, and extension to develop and manage a portfolio of food safety and capacity-strengthening activities.

MANAGEMENT TEAM

Dr. Haley Oliver
Director
Interim Vice Provost for Graduate Students and Postdoctoral Scholars
150th Anniversary Professor of Food Science
Sr. Research Fellow, Krach Institute for Tech Diplomacy at Purdue
Purdue University

Dr. Randy Worobo
Associate Director
Professor of Food Microbiology
Cornell University

Dr. Lauren Trondsen
Managing Director
Purdue University

Julie Hancock
Operations Specialist
Purdue University

Dr. Amanda Garris
Communications Manager
Cornell University

Allison Staley
Senior International Sponsored Funding Administrator
Purdue University

Elizabeth Alexander
Project Manager
Purdue University

Dr. Jonathan Sogin
Research Support Specialist
Cornell University

TECHNICAL EXPERTS

Dr. Kathryn Boor
Dean of the Graduate School
Vice Provost for Graduate Education
Cornell University

Dr. Amanda Deering
Professor of Food Science
Purdue University

Dr. Paul Ebner
Interim Department Head and
Professor of Animal Sciences
Purdue University

Dr. Levon Esters*
Vice Provost for Graduate Education
Dean of the Graduate School
The Pennsylvania State University
**Technical Expert through May 1, 2023, when he began a new position at The Pennsylvania State University*

Dr. Jacob Ricker-Gilbert
Interim Associate Department Head and
Professor of Agricultural Economics
Purdue University

Dr. Gerald Shively
Associate Dean and Director, International Programs in Agriculture
Professor of Agricultural Economics
Purdue University

Dr. Hui-Hui Wang
Associate Professor of Agricultural Sciences Education and Communication
Purdue University

Dr. Martin Wiedmann
Gellert Family Professor in Food Safety
Cornell University

Advisory Committee

The FSIL Advisory Committee is critical to meeting the Innovation Lab's goal of reducing the burden of foodborne disease and strengthening the food safety of nutrient-dense foods through transformative partnerships across academic, public, and private sectors. The management entity relies on Advisory Committee members to counsel FSIL on research priorities, represent FSIL in various capacities, and serve as a resource and support for FSIL research subaward processes.

The Advisory Committee consists of private sector experts in food safety, government agency representatives, and experts in cross-cutting themes.

Bob Baker
Senior Food Safety Advisor
World Food Programme

Betsy Baysinger
Director, Trade and Scientific
Capacity Building Division
United States Department of Agriculture Foreign
Agricultural Service

Dr. Kathryn Boor
Dean of the Graduate School and Vice Provost
for Graduate Education
Cornell University

Dr. Shibani Ghosh
Director, Feed the Future Innovation Lab for Food
Systems for Nutrition
Research Associate Professor, Friedman School of
Nutrition Science and Policy
Tufts University

Alex Samel
Chief of Party, Safety and Quality Investment in Livestock
Land O' Lakes Venture 37

Dr. Krista Jacobs
Director of Research, Evaluation, and Learning
Landesa

Dr. Ahmed Kablan
Senior Science Advisor
Food Safety Division, Center for Nutrition
Bureau for Resilience, Environment and Food Security
USAID

Dr. Gina Kennedy
Principal Scientist, Director of Research, Translation and
Innovation, Periodic Table of Foods Initiative
Alliance of Bioversity International and the International
Center for Tropical Agriculture

Howard Popoola
Vice President, Corporate Food Technology
and Regulatory Compliance
The Kroger Co.
Board Member, Global Food Safety Initiative

Where the Innovation Lab Works

In FY2024, the Food Safety Innovation Lab maintained four long-term projects in its initial focus countries of Bangladesh, Cambodia, Kenya, and Senegal and two short-term projects in Nepal and Nigeria.

List of Program Partners

U.S.	Arizona State University
	Cornell University
	Kansas State University
	Purdue University
	Tennessee State University
	Texas State University
	The Pennsylvania State University
	Tuskegee University
	University of Alaska Fairbanks
	University of Florida
	University of Georgia
	Utah State University
Bangladesh	Bangladesh Agricultural University
	University of Dhaka
Cambodia	Center of Excellence on Sustainable Agricultural Intensification and Nutrition
	Institut Pasteur du Cambodge
	Institute of Technology Cambodia
	Royal University of Agriculture
	World Vegetable Center
Kenya	Kenya Medical Research Institute
	University of Nairobi
Nepal	Agriculture and Forestry University
	SAHAVAGI
Nigeria	Bowen University
	Obafemi Awolowo University
	University of Ibadan
Senegal	Conseil National du Développement de la Nutrition
	Institut de Technologie Alimentaire
	Institut Sénégalais de Recherches Agricoles

Acronyms

AoI	Area(s) of Inquiry
AOR	Agreement Officer's Representative
CE SAIN	Center of Excellence on Sustainable Agricultural Intensification and Nutrition (Cambodia)
CNDN	Conseil National du Développement de la Nutrition (Senegal)
COVID-19	Coronavirus Disease 2019
DDL	Development Data Library
EMMP	Environmental Mitigation and Monitoring Plan
FAO	Food and Agriculture Organization of the United Nations
FS	Food Safety
FSIL	Feed the Future Innovation Lab for Food Safety
FY	Fiscal Year
GAPs	Good Agricultural Practices
GAqPs	Good Aquacultural Practices
GFSS	Global Food Security Strategy
GMP	Good Manufacturing Practices
IAFP	International Association for Food Protection
IBC	Institutional Biosafety Committee
IPC	Institut Pasteur du Cambodge (Cambodia)
IR	Intermediate Result
IRB	Institutional Review Board
ISRA	Institut Senegalais Recherches Agricoles (Senegal)
ITA	Institut de Technologie Alimentaire (Senegal)
ITC	Institute of Technology Cambodia
KAP	Knowledge, Attitudes, and Practices
KEMRI	Kenya Medical Research Institute
LGAs	Local Government Areas
ME	Management Entity
MEL	Monitoring, Evaluation, and Learning
MSI	Minority Serving Institution
NACOSTI	National Commission for Science Technology and Innovation (Kenya)
NARC	Nepal Agriculture Research Council
NCWSC	Nairobi City Water and Sewerage Company
NEFOSTA	Nepal Food Scientists and Technologists Association
NGOs	Non-Government Organizations
ODK	Open Data Kit
OSU	The Ohio State University
PhD	Doctor of Philosophy
PI	Principal Investigator
Q	Quarter
RFA	Request for Applications
RUA	Royal University of Agriculture (Cambodia)
SEG	Sector Environmental Guidelines
SOW	Scope of Work

TOC	Theory of Change
UoN	University of Nairobi
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
WGS	Whole Genome Sequencing
WP	Work Plan
WTP	Willingness to Pay

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Executive Summary

In FY2024, the Feed the Future Innovation Lab for Food Safety (FSIL) subaward projects in Bangladesh, Cambodia, Kenya, Nepal, Nigeria, and Senegal made significant progress in data collection to support the development of food safety practices and policies, analyze the gendered roles and opportunities within food safety in several different food value chains, and identify food safety interventions and strategies for their implementation. In the final year of activities, project teams focused on completing data collection, analyzing datasets, and disseminating results.

As projects completed their final milestones, several teams held events to share project findings with stakeholders involved with food safety policy. Policy-related activities included a National Policy Consultation on Produce Safety in Nepal (April 2024), a project dissemination event in Bangladesh (May 2024), and a structured group discussion method that enabled representatives from government, healthcare, environmental health, community health, market organizations, and the community to collectively identify and prioritize strategies for enhancing household food safety in Nigeria. Policy briefs are also being developed as projects complete their activities and prepare publications. In FY2024, FSIL subaward projects published three peer-reviewed journal articles, gave 22 conference presentations, and hosted workshops and training sessions for producers, extension agents, government stakeholders, and the private sector. Highlights include four produce safety workshops in Nepal that reached over 272 growers and extension agents, the distribution of a food safety manual developed by the Nepal project, and trainings in the dairy value chain in Senegal on food safety and quality control.

FSIL continued to partner with Purdue University's Ag Data Services to ensure that research teams have access to technical support related to data management and sharing. As projects entered the final phase of the project life cycle and finalized their datasets, Ag Data Services conducted frequent one-on-one meetings to ensure all datasets were completed and uploaded to the Harvard Dataverse and USAID's Development Data Library (DDL).

The FSIL ME continued to monitor and guide subaward activities through monthly meetings and conducted site visits in Bangladesh, Nepal, and Kenya. The 2023 annual meeting, held in Phnom Pehn, Cambodia, provided an opportunity for project leaders, USAID representatives, the FSIL ME, Technical Experts, and Advisory Committee members to share progress, learnings, and feedback. The event featured interactive panel discussions showcasing local capacity-building efforts and engagement with USAID officials, collaborators, and local farmers. In addition, FSIL highlighted project progress on Agrilinks, e-newsletters, and social media throughout the year with an emphasis on highlighting results and publications, capacity-strengthening efforts, and profiles of project researchers and graduate students. The ME also hosted two webinars in June 2024 to highlight project findings in social behavior change in food safety and engaging and empowering women.

June 24, 2024, marked the completion of FSIL Phase I. Subsequently, FSIL was awarded a five-year extension for Phase II. In Phase II, FSIL will support research that fills key evidence gaps, increases food safety awareness, and builds capacity to motivate consumer, government, and private sector action that strengthens food safety systems. The research will increase consumer awareness of and demand for safer food, empower governments to generate and use food safety data, and motivate the private sector to adopt safe food production practices.

Research Program Overview and Structure

In 2019, USAID selected Purdue University, in partnership with Cornell University, to lead the Feed the Future Innovation Lab for Food Safety. FSIL's vision is to strengthen food security for developing nations through research and capacity development that increases the production of, and access to, safe and nutritious food. FSIL aims to generate and facilitate the dissemination of knowledge, practices, and technologies that improve and enhance climate-resilient food safety systems for communities, households, and commercial value chains. In June 2024, FSIL was granted a five-year extension through June 2029. The annual report will focus on the FY2024 activities and accomplishments of FSIL Phase I research subawards and a newly awarded Phase II commissioned research project.

Alignment with the Global Food Security Strategy

Food safety intersects with three objectives of the U.S. Government Global Food Security Strategy FY2022-2026 (nutrition, resiliency, and economic growth), as it is necessary for food security. Therefore, there is a clear need to consider food safety challenges and opportunities when conducting and translating research designed within the strategy. FSIL's research portfolio is framed by three Areas of Inquiry (AoI), which closely align with the Global Food Security Strategy (GFSS) objectives.

- AoI 1 - Improved Nutrition and Human Outcomes: Research under this AoI focuses on the consumption of safe and affordable food as a means of reducing undernutrition. The AoI emphasizes that nutritious foods can still result in illness or disease in the event they are unsafe due to contamination with biological or chemical hazards.

- AoI 2 - Reduce and Mitigate Risk for Enhanced Resilience: Research under this AoI focuses on food safety behavior, practices, and awareness that are closely tied to a population's resilience. One of the overarching aims of resiliency is to reduce the human and economic costs of recurrent crises, which are exemplified in endemic diarrheal diseases caused by contaminated food and water.

- AoI 3 - Advancing the Productivity Frontier through Economic Development: Research under this AoI focuses on developing opportunities for foods and commodities to reach new local and export market opportunities. Developing and implementing advanced food safety regulations and monitoring systems will ensure products meet the international food safety standards required for entry into global trade.

Overview and Objectives

To enhance food safety globally, FSIL pursued the following objectives in Phase I:

- Increasing awareness of food safety
- Enhancing capacity to conduct food safety research
- Developing policies that enable conditions for food safety research, translation, and practice
- Accelerating translational research technologies and practices for households, communities, and the food industry

In Phase II, FSIL will support research that fills key evidence gaps, increases food safety awareness, and builds capacity to motivate consumer, government, and private sector action that strengthens food safety systems. The research will increase consumer awareness of and demand for safer food, empower governments to generate and use food safety data, and motivate the private sector to adopt safe food production practices.

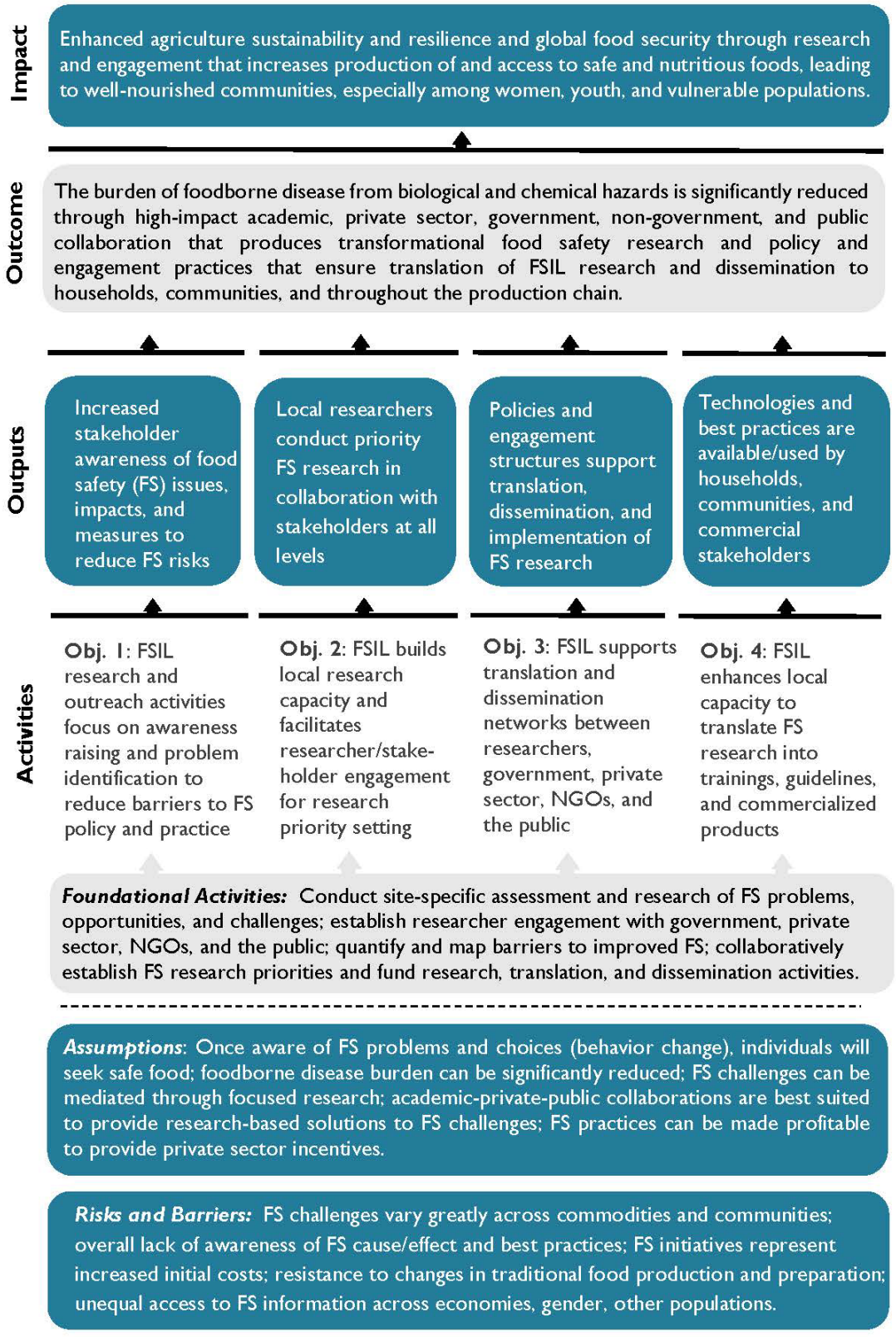
Research Portfolio Design

In FY2021, FSIL funded four competitively-awarded long-term subawards in Bangladesh, Cambodia, Kenya, and Senegal that built on the findings of FSIL's foundational research grants (QuickStarts). FSIL released its second request for applications (RFA) in April 2021, focusing on Minority Serving Institution (MSI)-led partnerships for global food safety research to complement the technical scope of active long-term subawards. The final selection and administration of subawards for two additional projects, based in Nepal and Nigeria, occurred in FY2022. FSIL maintained support for the six subawards throughout FY2024. Currently, each project has either completed activities or is in the final stages of completion, except Kenya's Phase II research, which began activities in April 2024. FSIL's Phase II commissioned research project initiated activities at the end of FY2024.

Cross-Cutting Themes

The cross-cutting themes of gender equity, youth engagement, human and institutional capacity development, and food safety-enabling environments were integrated across the FSIL research portfolio.

Theory of Change (TOC) and Impact Pathway for Food Safety (FS)



Focus Country Key Accomplishments

Bangladesh

In FY2024, the FSIL long-term subaward in Bangladesh completed the microbial analysis from a second pond experiment to compare contamination levels in fish produced using conventional methods and Good Aquacultural Practices (GAqPs). To aid the team in completing the microbiological analyses of fish samples, the FSIL ME and in-country microbiology PI hosted a weeklong training program for microbiology students and lab technicians in Q2 of FY2024. *Salmonella* and coliforms were detected less frequently in fish farmed using GAqPs than conventional methods. The team also completed surveys and focus group discussions with female fish farmers and consumers to understand women's food safety knowledge, attitudes, and practices, and household and farm gender roles. The results showed that although women had favorable attitudes towards food safety, few had received aquaculture training, and many were unaware of GAqPs. In addition, in focus group discussions female consumers indicated that they would be willing to pay more for safer fish, but they faced financial limitations, were unfamiliar with foodborne pathogens and chemical hazards, and lacked trust in local retailers to provide safe fish or accurate information about safety. A choice experiment was conducted, and the results indicated that consumers were willing to pay a premium for fish produced using GAqPs. Cumulative findings from the project were shared at a dissemination event in May 2024, with approximately 150 stakeholders, and a GAqP manual is being developed to support extension agents and farmers in implementing GAqPs. Two graduate students are expected to graduate in December 2024. Up to five additional publications are in preparation for submission during FY2025, and the project will officially conclude in FY2025.

FSIL's research aligns with the GFSS Bangladesh Country Plan[1] and particularly its component of Food Safety and Sanitary and Phytosanitary Standards. The Bangladesh subaward is generating food safety economics data that supports the development of food safety policy and the ongoing activities of the Bangladesh Food Safety Authority. Graduate students are also being trained by the project, enhancing local capacity to conduct research and monitor food safety issues.

Cambodia

In August 2024, FSIL concluded its long-term subaward activities in Cambodia, which included collecting and analyzing data for the willingness-to-pay (WTP) study on certified cucumbers and completing a second gender study to better understand how female vegetable producers' labor responsibilities and time are distributed and how their perceptions about opportunity impact their participation in agricultural education programs. Whole genome sequencing was conducted with bacterial isolates collected from farms, distribution centers, and markets, and the team conducted a capacity-building workshop focused on scientific writing. Two Cambodian graduate students participated in the International Association for Food Protection (IAFP) conference in Long Beach, California, where they presented findings from the microbial assessments during poster sessions. One master's student completed his degree, and two more are expected to graduate in December 2024. Three publications are anticipated for FY2025.

FSIL's research aligns with multiple Intermediate Results (IRs) and Sub-IRs outlined in the Cambodia Country Development Cooperation Strategy, particularly Sub-IR 1.1.3: Strengthened capacity in science, technology, and innovation for women and youth. The project enhanced both microbiological and social science research capacities in food safety while identifying and developing interventions to control high-risk bacterial pathogens in vegetable production, distribution, and sale.

Kenya

In Q3 and Q4 of FY2024, following the restructuring of the Kenya work plan and budget and after receiving approvals from USAID and partner institutions, several key accomplishments were achieved. Sub-agreements between Purdue University, the University of Nairobi (UoN), and Kenya Medical Research Institute (KEMRI) were finalized, and a detailed work plan, sampling plan, and laboratory protocols for detecting *Salmonella* and *Campylobacter* were established. The FSIL ME met with the PIs,

[1] https://cg-281711fb-71ea-422c-b02c-ef79f539e9d2.s3.us-gov-west-1.amazonaws.com/uploads/2018/11/Bangladesh_GFSS_Country_Plan_Public_CLEARED_7.11.18_508_Compliant.pdf

students, and lab technicians from KEMRI and UoN in May 2024 to onboard the project and assist with several project planning activities. A Knowledge, Attitudes, and Practices (KAP) survey tool was finalized and uploaded to the Open Data Kit (ODK) platform for training interventions. Institutional approvals, including Institutional Review Board (IRB) and biosafety clearances, were secured, and two gender study manuscripts were drafted for submission to peer-reviewed journals in FY2025. Three M.S. students and two Ph.D. students will receive support from the project and remain engaged in research activities in FY2025.

FSIL's emphasis on food safety in the poultry value chain aligns with the GFSS Kenya Country Plan[2] and its inclusion of poultry as a Tier 2 commodity. The FSIL subaward in Kenya partners with women and youth poultry farmers on the identification and testing of food safety interventions.

Senegal

In FY2024, FSIL's long-term subaward in Senegal made progress in addressing food safety challenges in Senegal's dairy value chain. Analysis of survey data revealed major gaps in dairy producers' access to training and information and low concern about illness from unsafe milk, with 23% of households consuming milk rejected by mini-dairies and only 5% of reporting witnessing illness from unsafe milk. Resource constraints including limited access to financing, cold chain, and transport infrastructure further hampered the adoption of safe practices for both producers and processors. The team also collected baseline data on foodborne pathogens from milk samples in Saint Louis, which revealed unsanitary conditions and the presence of harmful bacteria such as *Listeria monocytogenes*. Baseline data collection in Louga and Matam regions is set to conclude in early FY2025. Capacity-building activities included progress in the development of posters to promote safer practices among dairy farmers, processors, and collectors, laboratory training sessions conducted by Co-PI Dr. Abebe, and a week-long collaboration with a local mini-dairy to improve safety and quality control in addition to supporting product development such as flavored milk and yogurt. Additionally, two Senegalese graduate students presented research at the IAFP 17th Dubai International Food Safety Conference, and the final two graduate students are expected to complete their degrees in FY2025. The project will conclude in FY2025.

FSIL's ongoing research aligns with the GFSS Senegal Country Plan[3] and its aim to develop a functional food safety regulatory system based on sound science and international standards. The project is raising awareness of food safety issues and their impact on public health, conducting research-based food safety training programs, and identifying practical food safety interventions.

Nepal

In FY2024, the Nepal short-term subaward successfully achieved its project objectives, focusing on research related to food safety behaviors among producers and consumers. Results from surveys of 1,052 commercial fresh produce growers across 10 districts were analyzed to assess producers' adoption of specific aspects of Good Agricultural Practices (GAPs), current food safety knowledge, and willingness to incur costs to maintain food safety. Among GAPs, the development of farm food and water safety plans; produce handling; and worker hygiene were identified as important topics for future training and outreach. The food safety economics experiment showed that producers' willingness to accept higher production costs was positively influenced by education, land holdings, risk attitude, and credit access, and the model predicts that producers are willing to incur an additional cost of 13% to maintain food safety. The project made noteworthy progress in capacity-building efforts through the delivery of five comprehensive GAPs training programs that engaged 341 fresh produce growers and extension workers across four provinces. With assistance from the FSIL ME, the team also produced a comprehensive GAPs manual specific to Nepal emphasizing microbial food safety for produce growers and extension workers; the manual was published in English in Q3 of FY2024 and will be published in Nepali in Q1 of FY2025. Additionally, Agriculture and Forestry University,

[2] https://cg-281711fb-71ea-422c-b02c-ef79f539e9d2.s3.us-gov-west-1.amazonaws.com/uploads/2018/11/FTF_Kenya_Country_Plan_WS_Edits_9.21.pdf
[3] https://cg-281711fb-71ea-422c-b02c-ef79f539e9d2.s3.us-gov-west-1.amazonaws.com/uploads/2018/11/Senegal_Country_Plan_WS_Edits.pdf

the Nepal Food Scientists and Technologists Association, and the FSIL ME hosted a national policy consultation in April 2024 to disseminate project findings and foster dialogue on produce safety.

FSIL's research supports the GFSS Nepal Country Plan[4] and its focus on improving access to and use of diverse, safe, and nutritious foods. By equipping entrepreneurs and policymakers with guidance for market-led, demand-driven food safety practices and labeling recommendations for fresh produce, informed by analysis of consumer behavior, the project aimed to stimulate a rapid increase in access to safe and nutritious produce in Nepal.

Nigeria

In FY2024, the FSIL short-term subaward in Nigeria completed its project activities, focusing on women's insights into household food safety challenges using the *Our Voice* Discovery Tool mobile application. Fifty-five mothers participated as citizen scientists, receiving training to document their experiences with food safety over five days. Through responses to prompts and photos of their households and communities, they highlighted barriers they faced in providing safe, nutritious food for their families. The project convened focus groups with the mothers to identify themes and strategies for improving household food safety. An abstract of these findings has been submitted for presentation at the Society for Nutrition Education and Behavior annual meeting.

Additionally, the project team conducted key informant interviews with public health officials and civil society representatives, and organized focus group discussions to explore the roles of environmental health officers and community members in promoting food safety. Five nominal group technique sessions were held, generating and ranking actionable ideas related to awareness, partnerships, infrastructure, and policy changes. This participatory approach empowered the community and enhanced local capacity to tackle food safety challenges. A manuscript detailing these findings is under review at *BMC Public Health*, with four additional manuscripts and two reports in progress.

FSIL research aligns with the GFSS Nigeria Country Plan's[5] Component C: Improving Access to and Use of Diverse, Safe, Nutritious, and High-Quality Foods. By understanding the most common food safety risks in households, levels of childhood stunting, the challenges faced by mothers in providing safe and nutritious foods for their children, and the critical policy needs to support the implementation of Nigeria's national food safety plan, the project prioritized programs and policy actions to improve household food safety.

Commissioned Research

The first project in FSIL's Phase II was launched in September 2024. The one-year research project will identify drivers of and barriers to the adoption of food safety behaviors in Cambodia, Kenya, and Nepal. Similar to the QuickStart projects in FSIL's Phase I, this is a short, one-year project that will inform future FSIL research. It will capture consumer perspectives on unsafe food consumption, food safety policies, and the demand for safer foods, with special attention to household-level food safety dynamics. The results can inform national strategies to boost food safety awareness and drive demand for safer foods. Data will support researchers, policymakers, and food producers in developing food safety solutions and guide FSIL's future research, with direct benefit to future subawards in Cambodia, Kenya, and Nepal.

[4] https://cg-281711fb-71ea-422c-b02c-ef79f539e9d2.s3.us-gov-west-1.amazonaws.com/uploads/2018/11/GFSS-Nepal-Country-Plan.pdf
[5] https://cg-281711fb-71ea-422c-b02c-ef79f539e9d2.s3.us-gov-west-1.amazonaws.com/uploads/2018/11/Nigeria_GFSS_Country_Plan_-_Final_WS_Edits_2.pdf

Research Project Reports

Enhancing Food Safety in Fish and Chicken Value Chains of Bangladesh (Bangladesh Long-Term Subaward)

Location: Bangladesh; Districts: Mymensingh, Bogura, Dhaka, Gazipur, Jashore, Khulna, Patuakhali, and Rajshahi

Description: The project promotes informed decisions and actions to enhance the food safety of farmed fish and frozen uncooked chicken products. By identifying areas along the value chain that need improvement and developing tools to quantify the benefits of improved food safety, the project fosters an enabling environment to support consumers' access to safe, nutritious food products.

Theory of Change and Impact Pathway(s): This project contributes toward Objectives 1-4 of the FSIL TOC.

Collaborators: Texas State University (U.S.), University of Dhaka (Bangladesh), Bangladesh Agricultural University (Bangladesh)

Achievements (Aligned with Bangladesh WP Objective 1)*:*

The project team completed the data analysis from a second pond experiment to compare bacterial contamination levels (total viable count, total coliform count, and *Salmonella* count) in fish produced using conventional methods and Good Aquacultural Practices (GAqPs), which included a custom feed produced in partnership with Spectra Hexa Feeds, Ltd. *Salmonella* and coliforms were present in fish farmed under both types of production practices, but they were detected less frequently in fish farmed using GAqPs than conventional methods.

The project team also completed surveys and focus group discussions with female fish farmers and consumers to understand women's food safety knowledge, attitudes, and practices (KAPs); household and farm gender norms; and unpaid working hours. The results showed that among female fish producers, 86% of women had favorable attitudes towards food safety and safe fish production, but 85% had not received any aquaculture training and 30-40% were unaware of GAqPs. In addition, female farmers worked an average of 2.4 unpaid hours per day on aquaculture-related tasks.

A choice experiment was conducted to understand consumers' fish purchasing decisions using visible and safety attributes along with different product prices. The result showed that most consumers prefer fish produced using GAqPs compared to conventional practices based on both visible attributes and stated safety attributes of the fish. The project also completed analysis of data from eight focus group discussions in seven towns to understand female consumers' food safety KAPs and WTP for safer fish. Female consumers indicated they would be willing to pay more for safer fish, but they faced financial limitations, were unfamiliar with foodborne pathogens and chemical hazards, and lacked trust in local retailers to provide safe fish or accurate information about safety.

A cost-benefit analysis showed that adoption of GAqPs may increase farmer profits. In pond trials, it was determined the adoption of GAqPs did not increase the per unit cost of production, yet the per unit selling price was higher for fish produced using GAqPs, resulting in higher profit. GAqPs resulted in larger fish yields, which reduced the per-unit production costs. In addition, fish feed is one of the most expensive inputs for fish farmers, but the use of fewer feed additives dictated by GAqPs can reduce the cost of commercial feed production, resulting in lower feed expenses for farmers. Findings were shared with approximately 150 stakeholders in May 2024, and a GAqP manual is being developed to support extension agents and farmers in adoption of food safety practices.

Capacity Building:

The project established key partnerships with institutions including the Bangladesh Fisheries Research Institute, the Bangladesh Food Safety Authority, and the Department of Fisheries, along with private collaborators like Spectra Hexa Feeds and local fish farmers. These collaborations have been crucial in promoting Good Aquaculture Practices (GAqPs) and developing training

resources and certification programs. The project also emphasizes academic capacity building, supporting two Ph.D. and eight master's students, most of whom are women, reinforcing its commitment to gender inclusion in research and education. In addition, the FSIL ME provided a hands-on week-long training in microbiology lab techniques for students at the University of Dhaka to prepare them to successfully complete the project research and their theses.

Lessons Learned and Broader Application:

A key lesson from the project has been the critical importance of engaging public and private stakeholders throughout project planning and implementation. Active involvement from government stakeholders, including high-level officials from the Department of Fisheries, Bangladesh Fisheries Research Institute, and the Bangladesh Food Safety Authority, has been instrumental in securing strong institutional buy-in and support. Equally important has been the close collaboration with farmers and private industry partners, such as Spectra Hexa Feeds Limited, which has facilitated a more integrated and practical approach to achieving the project's objectives.

Publications and Presentations:

Dey, M. M. (2024, June 20). Harnessing consumers' food safety perceptions and willingness to pay for safer fish in Bangladesh [Webinar]. In *Feed the Future for Innovation Lab for Food Safety Webinar Series—Social Behavior Change in Food Safety: Levers to Drive Food Systems Transformation*. Retrieved from https://ag.purdue.edu/food-safety-innovation-lab/projects/resources/social-behavior-change-in-food-safety-levers-to-drive-food-system-transformation-webinar-video

Dey, M. M., Rahman, M. S., Dewan, M. F., Sudhakaran, P. O., Deb, U., & Khan, M. A. (2024). Consumers' willingness to pay for safer fish: Evidence from experimental auctions in Bangladesh. *Aquaculture Economics & Management*, *28* (3): 460-490. https://doi.org/10.1080/13657305.2024.2353212

Dey, M. M., Rahman, M. S., Khan., M. A., Dewan, M. F., Nazir, K. H. M. N. H., & Sudhakaran, P. O. (2024). Safer fish consumption in Bangladesh—Unveiling willingness to pay through experimental auction [Conference presentation]. 3rd Biennial International Conference of Fisheries Society of Bangladesh, Mymensingh, Bangladesh.

Khushi, H., Sudhakaran, P. O., Rahman M. S., Khan, M. A., & Dey, M. M. (2024). Consumers' willingness to pay for safer fish in Bangladesh [Conference presentation]. Aquaculture America 2024, San Antonio, Texas, USA.

Luthfa, S. (2024, June 26). Women's voices on food safety in Bangladesh's fish value chain [Webinar]. In *Feed the Future for Innovation Lab for Food Safety Webinar Series—Engaging and Empowering Women to Strengthen Food Safety: Lessons Learned in Bangladesh, Cambodia, and Nigeria*. Retrieved from https://ag.purdue.edu/food-safety-innovation-lab/projects/resources/engaging-and-empowering-women-to-strengthen-food-safety-lessons-learned-in-bangladesh-cambodia-and-nigeria-webinar-video

Mandal, A., Dolon, U. T., Khan, M. A., Rahman, M. S., Sudhakaran, P. O., & Dey, M. M. (2024). Assessing women's involvement and their knowledge, attitude and practices (KAPs) on safe fish production [Conference presentation]. Aquaculture America 2024, San Antonio, Texas, USA.

Rahman, M. S., Dey, M. M., & Dewan, M. F. (2024). Determinations of factors influencing willingness to pay for safer fish consumption in Bangladesh [Conference presentation]. 68th Annual Conference of The Australasian Agricultural & Resource Economics Society, Canberra, Australia.

Rahman, M. S., Dey, M. M., Dewan, M. F., Khan., M. A., Nazir, K. H. M. N. H., & Sudhakaran, P. O. (2024). Assessing good aquaculture practices (GAqP) know-how and consumers' willingness to pay for safer fish in Bangladesh [Conference presentation]. 6th National Scientific Conference on Food Safety and Health, Dhaka, Bangladesh.

Rahman, M. S., Dey, M. M., Khan, M. A., Dewan, M. F., Nazir, K. H. M. N. H., & Sudhakaran, P. O. (2024). From pond to plate: assessing fish producers' know-how and consumers' willingness to pay for safer fish in Bangladesh [Conference presentation]. Aquaculture America 2024, San Antonio, Texas, USA.

Reducing Foodborne Pathogen Contamination of Vegetables in Cambodia: Innovative Research, Targeted Interventions, and Impactful, Cambodian-Led Engagement (Cambodia Long-Term Subaward)

Location: Cambodia; Siem Reap and Battambang provinces, Phnom Penh municipality

Description: The goal of the project was to safeguard the nutritional gains of a healthy diet for Cambodian children, households, and communities by strengthening food safety across the vegetable value chain. Project partners worked to bridge existing food safety gaps and solidify shared food safety agendas across universities and the public and private sectors. Together, they tested and implementing data-driven strategies to reduce the incidence of foodborne pathogen contamination of vegetables consumed in Cambodia.

Theory of Change and Impact Pathway(s): This project contributes toward Objectives 1-4 of the FSIL TOC.

Collaborators: Kansas State University (U.S.), Purdue University (U.S.), The Pennsylvania State University (U.S.), Royal University of Agriculture (RUA; Cambodia), Center of Excellence on Sustainable Agricultural Intensification and Nutrition (CE SAIN; Cambodia), Institute of Technology Cambodia (ITC; Cambodia), Institut Pasteur du Cambodge (IPC; Cambodia), World Vegetable Center (Cambodia)

Achievements (Aligned with Cambodia WP Objective 1)*:*

As the project concluded its activities, efforts focused on capacity-building initiatives and completing data analysis for the willingness-to-pay (WTP) study, assessment of microbial contamination across the value chain, and gender research projects. The WTP study revealed that consumers are willing to pay higher price premiums for USDA Organic cucumbers compared to CamGAP-certified and conventionally grown varieties. These findings were submitted as a proceedings paper to the International Conference of Agricultural Economists. Additionally, data collection on women's time and labor on vegetable farms and a second gender study was completed.

The project's microbiological assessments were presented through poster sessions at the 2024 International Association for Food Protection (IAFP) annual meeting in Long Beach, California. The results highlighted persistent *Salmonella* transmission within value chains, underscoring the critical need for improved agricultural and potable water supplies and safer vegetable display practices, especially during the rainy season. Planned publications for FY2025 will address the baseline microbial assessment, findings from the WTP study, gender analysis, and surface sanitation results related to *Salmonella* and *E. coli* contamination.

Capacity Building:

The project successfully conducted two virtual and one in-person session focused on scientific writing, covering essential topics such as how to write an abstract, structure a manuscript, add citations and references, and understand the peer review process, as well as how to create posters and other materials for presentations. These sessions played a critical role in capacity building by enhancing participants' ability to disseminate knowledge, foster collaboration, and apply evidence-based practices in their research. The sessions were attended by students from RUA and ITC, as well as project Co-PIs and technicians from IPC. Notably, two graduate students from RUA, supported by the project, will be the first to graduate from their respective programs in food safety and social science, marking a significant milestone in advancing academic and professional capacity in these fields.

Lessons Learned and Broader Application:

Overall, the project was highly successful in identifying both microbial and human factors contributing to pathogen contamination in Cambodia's vegetable value chain. Looking ahead, future efforts should focus on education, communication, and policy-level interventions to address these risks and enhance food safety practices throughout the supply chain.

Publications and Presentations:

Chhoeun, M., Sokhom, P., Chrun, R., Ouk, K., Sreng, N., Peng, C., Bello, N. M., Ebner, P., & Vipham, J. L. (2024). Detection of *Salmonella enterica* and *Escherichia coli* on vegetables sold utilizing two different selling methods in fresh food markets in Battambang Province, Cambodia [Poster presentation]. IAFP 2024 Annual Meeting, Long Beach, CA, United States. https://iafp.confex.com/iafp/2024/onlineprogram.cgi/Paper/35441

Ebner, P. (2024, June 20). Using behavior theory to understand adoption of food safety practices [Webinar]. In *Feed the Future for Innovation Lab for Food Safety Webinar Series—Social Behavior Change in Food Safety: Levers to Drive Food Systems Transformation.* Retrieved from https://ag.purdue.edu/food-safety-innovation-lab/projects/resources/social-behavior-change-in-food-safety-levers-to-drive-food-system-transformation-webinar-video/

Mwambi, M., Schreinemachers P., Habiyaremye, N., Bonnarith, U., & Ebner, P. (2024). A lab-in-the-field experiment to assess consumers' willingness to pay for safe vegetables in Phnom Penh, Cambodia [Conference presentation]. 32nd International Conference of Agricultural Economists, New Delhi, India.

Salazar, A., Vipham, J. L., Peng, C., Sreng, N., Fu, Y., Nawrocki, E., Dudley, E. G., & Kovac, J. Whole-Genome Sequencing of *Salmonella* Isolated from a Vegetable Supply Chains in Cambodia Revealed a High Serovar Diversity and Signs of Persistence and Transmission in the Supply Chain [Poster presentation]. IAFP 2024 Annual Meeting, Long Beach, CA, United States. https://iafp.confex.com/iafp/2024/onlineprogram.cgi/Paper/35264

Sokhom, P., Chhoeun, M., Ouk, K., Chrun, R., Peng, C., Heng, O., Chanto, M. T., Sreng, N., Bello, N. M., Ebner, P., & Vipham, J. L. (2024). Prevalence of *Escherichia coli* and S*almonella enterica* in fresh vegetable and environmental samples from farm to market in the province of Battambang, Cambodia [Poster presentation]. IAFP 2024 Annual Meeting, Long Beach, CA, United States. https://iafp.confex.com/iafp/2024/onlineprogram.cgi/Paper/35182

Tep, P., Bun, B., Chhoeun, M., Ouk, K., Chrun, R., Peng, C., Sem, C., Sreng, N., Bello, N. M., Ebner, P., & Vipham, J. L. (2024). Prevalence of *Escherichia coli* and *Salmonella enterica* in the vegetable value chain in the province of Siem Reap, Cambodia [Poster presentation]. IAFP 2024 Annual Meeting, Long Beach, CA, United States. https://iafp.confex.com/iafp/2024/onlineprogram.cgi/Paper/35462

Thompson, L. (2024, June 26). Informing food safety engagement: A gender analysis of Cambodian vegetable production [Webinar]. In *Feed the Future for Innovation Lab for Food Safety Webinar Series—Engaging and Empowering Women to Strengthen Food Safety: Lessons Learned in Bangladesh, Cambodia, and Nigeria.* Retrieved from https://ag.purdue.edu/food-safety-innovation-lab/projects/resources/engaging-and-empowering-women-to-strengthen-food-safety-lessons-learned-in-bangladesh-cambodia-and-nigeria-webinar-video

Baseline Microbial Food Safety Assessment of the Kenya Poultry Value Chain (Phase II Kenya Long-Term Subaward)

Location: Kenya; Kiambu County

Description: Phase II of the Kenya long-term subaward builds off the Phase I Chakula Salama project to improve food security and nutrition in Kenya. In-country project leaders will assess the prevalence of *Salmonella* and *Campylobacter* on farms and in retail establishments in the poultry value chain and conduct whole genome sequencing on pathogen samples. In addition, whole metagenome sequencing will be conducted on wastewater streams to identify foodborne pathogens. Results from the gender study in Phase I will be disseminated through peer-reviewed publications.

Theory of Change and Impact Pathway(s): This project contributes toward Objectives 1-4 of the FSIL TOC.

Collaborators: Kenya Medical Research Institute (KEMRI; Kenya), University of Nairobi (UoN; Kenya)

Achievements (Aligned with Kenya WP Objective 1):

Phase II of the Kenya long-term subaward was officially initiated in FY2024. The scope of work and budgets for the project were completed and approved by all partner institutions and USAID. Sub-agreements between Purdue University, UoN, and KEMRI were finalized, and a detailed work plan was collaboratively developed by FSIL, UoN, and KEMRI.

A comprehensive sampling plan and laboratory protocols for the detection of *Salmonella* and *Campylobacter* were also established, including a detailed list of lab supplies and costs. The survey tool for a Knowledge, Attitudes, and Practices (KAPs) survey was finalized and uploaded to the Open Data Kit (ODK) platform to be used when microbial sampling is completed. Institutional approvals, including IRB and biosafety clearances, were obtained from UoN, KEMRI, and the National Commission for Science Technology and Innovation (NACOSTI). Additionally, two gender study manuscripts were drafted and will be submitted to peer-reviewed journals in FY2025.

Capacity Building:

The FSIL ME collaborated with project Principal Investigators at KEMRI and UoN to develop the sampling plan and laboratory protocols for the detection of *Salmonella* and *Campylobacter*, which required adapting the current ISO 6579-1 and 10272-1 protocols to accommodate available supplies and laboratory capacity. The FSIL ME also plans to support the project with in-person training in early FY2025. Two Ph.D. students have been supported through the project. One is completing manuscripts sharing results of the previously completed gender analysis, and the other was extensively involved in developing the laboratory protocols and KAPs survey.

Lessons Learned and Broader Application:

In launching Phase II of the project, timely procurement of lab supplies within Kenya has been a significant barrier to initiating research activities. For future activities, project timelines should include sufficient time to receive lab supplies and expedite planning for activities that require supplies.

Publications and Presentations:

None to report

Food Safety Capacity Building in Senegal: Enhancing Resilience of the Dairy Value Chain by Leveraging Public-Private Partnerships (Senegal Long-Term Subaward)

Location: Senegal; Louga, Matam, and Saint Louis regions

Description: The goal of the project is to transform the overall safety of dairy and dairy products produced in Senegal, which will improve the nutritional status and economic prospects for the women and youth who play critical roles in dairy production. Project partners are advancing data-driven food safety practices, policies, and training to support the development of well-equipped food safety professionals in Senegal.

Theory of Change and Impact Pathway(s): This project contributes toward Objectives 1-4 of the FSIL TOC.

Collaborators: University of Georgia (U.S.), Tuskegee University (U.S.), Institut de Technologie Alimentaire (ITA; Senegal), Institut Sénégalais de Recherches Agricoles (ISRA; Senegal), Conseil National du Développement de la Nutrition (CNDN; Senegal)

Achievements (Aligned with Senegal WP Objective 1)*:*

In FY2024, the project team analyzed survey data on food safety practices, perceptions, and gendered differences in the Zones of Influence, revealing significant challenges for dairy producers. Survey data showed that a majority of producers lacked access to training or information on dairy safety and showed limited awareness of foodborne illness from milk, with only 5% reporting witnessing illness from unsafe milk despite a high prevalence of bacterial contamination. Additionally, 23% of households consumed milk rejected by mini-dairies. Resource constraints such as limited access to finance, cold chain, and transport infrastructure further hindered producers' ability to adopt safe practices. These findings align with assessments from mini-dairies, highlighting the need for capacity building and investments to address resource constraints in the sector.

The project also collected baseline data on pathogens in milk samples from farms and processors in Saint Louis, with efforts in Louga and Matam regions expected to conclude in early FY2025. Preliminary findings revealed unsanitary milking conditions leading to high levels of aerobic bacteria and coliforms and the presence of harmful pathogens like *Listeria monocytogenes* and *Staphylococcus* spp. While pasteurization or fermentation can eliminate these pathogens, pre-formed heat stable toxins produced prior to fermentation or pasteurization may still cause illness, and thus maintaining sanitary conditions during processing is a crucial preventative measure. The project is working with stakeholders to identify key intervention points across the supply chain for future training efforts. Additionally, two graduate students presented their research at the IAFP 17th Dubai International Food Safety Conference, and a third is preparing for a thesis defense.

Capacity Building:

In April, Co-PI Dr. Abebe conducted training sessions for laboratory personnel on milk sample collection, microbiological analysis, and equipment optimization. On April 19th, ITA held a food safety and quality standardization training for 12 processors, with a focus on women and youth from milk processing units. Additionally, ITA conducted a week-long one-on-one training and collaboration with a local mini-dairy to address gaps in product development, safety practices, and quality control identified by previous surveys. The team also developed posters to communicate safer production and processing practices for dairy producers and processors. The final Senegalese graduate student is expected to complete her degree during FSIL Phase II.

Lessons Learned and Broader Application:

Due to previous delays in the project, a no cost extension was needed beyond the original period of performance for the project. However, cost extensions could not be given to the University of Georgia or their second-tier subawards until FSIL received its own five-year extension. The time required to extend sub-agreements and subsequent second-tier sub-agreements after FSIL

received an extension led to additional delays. The microbial sampling has also required additional time due to limited laboratory capabilities, challenges in procuring supplies, and a shortage of trained personnel.

Publications and Presentations:

Marter-Kenyon, J. (2024, June 20). Opportunities for private sector behavior change in the dairy value chain in Senegal [Webinar]. In *Feed the Future for Innovation Lab for Food Safety Webinar Series—Social Behavior Change in Food Safety: Levers to Drive Food Systems Transformation*. Retrieved from https://ag.purdue.edu/food-safety-innovation-lab/projects/resources/social-behavior-change-in-food-safety-levers-to-drive-food-system-transformation-webinar-video/

Market-Led Food Safety in Nepal: Harnessing Production Incentives and Consumer Awareness (Nepal Short-Term Subaward)

Location: Nepal; Morang, Sarlahi, Kaski, Chitwan, Makawanpur, Kathmandu, Kalikot, Surkhet, Palpa, Banke, Rupandehi

Description: The goal of the project was to stimulate a rapid increase in access to nutritious produce in Nepal by identifying the factors that will drive the supply of and demand for safer salad vegetables. Researchers assessed indicators of current food safety risks, the food safety behaviors of vegetable producers and consumers, and incentives that could transform food safety policies and practices. The findings from this project will enable entrepreneurs and policymakers to reach informed decisions on prioritizing food safety investments and support the awareness of safer food consumption and dietary diversity in Nepali households.

Theory of Change and Impact Pathway(s): This project contributes towards Objectives 1-4 of the FSIL TOC.

Collaborators: Tennessee State University (U.S.), Arizona State University (U.S.), SAHAVAGI (Nepal), Agriculture and Forestry University (Nepal)

Achievements

In FY2024, the project successfully concluded its activities with a focus on food safety in Nepal. A key achievement was hosting a national policy consultation on April 18, 2024, in collaboration with Agriculture and Forestry University and the Nepal Food Scientists and Technologists Association (NEFOSTA), with support from the Feed the Future Food Systems for Nutrition Innovation Lab. The event brought together 120 participants, including government representatives, academics, farmers, distributors, private sector actors, and civil society organizations. The workshop served as a platform to disseminate the project's findings and foster dialogue aimed at sustaining momentum on produce safety.

The project published results from several studies, including the choice experiment with information nudges about food safety focusing on youth as well as the analysis of *E. coli* prevalence in water samples used by consumers and farmers to wash produce. In the choice experiment, youth chose cucumbers with labels indicating both chemical and microbial safety 40% more often than unlabeled cucumbers despite a price premium of 60 Nepalese Rupees. In addition, youth were more likely to choose an option with food safety labeling when they had greater awareness of the importance of food safety or were reminded of it through an informational nudge. The prevalence findings highlighted the critical importance of water quality in Nepal's fresh produce systems. Using *E. coli* as a contamination risk indicator, the research showed that water sources used by both growers and consumers to wash fresh produce had contamination levels that required urgent attention.

Data analysis was completed for surveys of produce farmers' food safety KAPs as well as their willingness to incur increased costs of production to provide a safer product. In a survey of 1,052 growers across 10 districts, producers were willing to incur an additional 13% cost to improve food safety. Key considerations to incentivize producers' investment in food safety include access to credit and financial support, food safety awareness and education, market access, land ownership, risk perception, and risk mitigation. The research also revealed that the current level of adoption and understanding of food safety-related Good Agricultural Practices among producers remains low. To address this gap, the project has initiated strategic steps outlined in the capacity-building section of this report. These results were shared at the 2024 Southern Agricultural Economics Association meeting, FSIL's 2024 Annual Meeting, and FSIL's June 2024 webinar on social behavior change, and the manuscripts for peer-reviewed journal articles based on these findings are currently in preparation.

Capacity Building:

In FY2024, the project made significant strides in capacity-building by training a total of 272 fresh produce growers and extension workers across five key vegetable production regions in Nepal. These trainings focused on best practices for food safety throughout the entire produce production chain including cultivation, harvest, post-harvest handling, and market connections. To ensure the sustainability of these efforts, approximately 500 copies of the training manual developed by the

project were printed and disseminated to stakeholders across the Nepali fresh produce value chain. The manual was made available in English, and a Nepali translation is being developed to maximize its reach and impact.

The project also strengthened existing partnerships and established new collaborations in Nepal's food safety sector. Key new collaborators, including FAO-Nepal, the Nepal Government's Plant Quarantine and Pesticide Management Center, the Nepal Agriculture Research Council (NARC), and NEFOSTA, contributed to the development of the training manual and the organization of workshops. These partnerships enhanced the capacity of involved organizations to collaborate effectively, host multi-stakeholder events, and engage in research and grant opportunities, positioning them for future growth and contributions to Nepal's food safety efforts.

Lessons Learned and Broader Application:

Nepal is experiencing rapid changes in government structure and composition within its high-level political systems. To effectively engage with government ministries and leaders, multiple strategies and avenues for outreach are needed. Advanced planning, combined with the flexibility to adapt to changes, will be crucial for executing programs on schedule. Additionally, leveraging connections through direct and related projects can facilitate our approach to agencies and stakeholders, enhancing their participation and support.

Publications and Presentations:

Khanal, A. R., Gurung, R., Timilsina, R., & Poudel, S. (2023). Awareness of food safety to ensure food security: examining gender roles in safer fresh produce consumption among metropolitan households in Nepal [Conference presentation]. Agricultural Policies and Practices in Nepal: Pathways for Transformation, Kathmandu, Nepal.

Khanal, A. R., Timilsina, R., & Gurung, R. (2023). Gender-based decisions on food shopping and preparation and diet diversity: Examining food safety and nutritional awareness and gender roles in consumer households in Nepal [Conference presentation]. CGIAR GENDER Impact Platform. From research to impact: Towards just and resilient agri-food systems, Delhi, India.

Khanal., A. R., Timilsina, R. H., & Dhungana, P. (2024). Do environmental awareness and food safety information nudges enhance youth's affinity to safer food consumption? Findings from an experiment in Nepal. *Journal of Agribusiness in Developing and Emerging Economies*. https://doi.org/10.1108/JADEE-01-2024-0019 10.1108/JADEE-01-2024-0019

Khanal, A. R., Timilsina, R. H., Sharma, B., Pokharel, B., & Aryal, R. (2024). Contaminated water and an indication of risk: Examining microbial contamination in the water used by consumers and commercial growers in fresh produce systems in Nepal. *Journal of Food Protection*, *87*(3). https://doi.org/10.1016/j.jfp.2024.100228

Kilonzo-Nethenge, A., Sogin, J. H., Timilsina, R. H., Khanal, A. R., Adhikari, D., & Adhikari, S. (2024). *Fresh Produce Safety and Good Agricultural Practices for Produce Growers in Nepal, A Grower's Guide*. Feed the Future Innovation Lab for Food Safety, Purdue University. https://doi.org/10.7910/DVN/0GCLNK

McGuire, E., Bryan, E., Gurung, R., & Larson, J. (2023). Gender integration across the USAID Feed the Future Innovation Labs [Panel session]. CGIAR GENDER Impact Platform. From research to impact: Towards just and resilient agri-food systems, Delhi, India.

Timilsina, R. H., Aryal, R., Poudel, S. R., & Khanal, A. R. (2024). Assessment of Food Safety Knowledge Among Fresh Produce Growers and Extension Workers Before and After Training in Nepal. *Agriculture Development Journal, 17*(1): 1–9. https://doi.org/10.3126/adj.v17i1.67859

Timilsina, R., Dhungana, P., Aryal, R., Ghimire, S., & Khanal, A. R. (2024) Willingness to accept cost for the adoption of food safety practices on fresh produce systems by producers: A case from Nepal [Conference presentation]. Southern Agricultural Economics Association (SAEA) 2024 Annual Meeting, Atlanta, Georgia, United States.

Strengthening Household and Community Food Safety in Nigeria (Nigeria Short-Term Subaward)

Location: Nigeria; Ibadan

Description: The project identified facilitators of and barriers to reducing the prevalence of foodborne disease in Nigerian households with young children. Using a community-based approach that harnesses the perspectives of youth, mothers, primary health care providers, community development personnel, government representatives, civil society leaders, and community-based organizations, researchers collaboratively identified strategic, feasible activities to mitigate and prevent household foodborne illnesses.

Theory of Change and Impact Pathway(s): This project contributes towards Objectives 1-4 of the FSIL TOC.

Collaborators: University of Alaska Fairbanks (U.S.), Utah State University (U.S.), Bowen University (Nigeria), Obafemi Awolowo University (Nigeria), University of Ibadan (Nigeria)

Achievements (Aligned with Nigeria WP Objective 1)*:*

Project activities were completed in FY2024. The project team documented women's insights on the assets, barriers, and challenges faced in providing nutritious food for their families using the *Our Voice* Discovery Tool mobile application. Fifty-five mothers from five Local Government Areas (LGAs) in the Ibadan Metropolis were recruited as citizen scientists. After receiving training on the app, these participants engaged in a three-step process to explore factors contributing to food safety vulnerability. Over five days, they responded to prompts and captured images that illustrated both the supports and obstacles to providing safe, nutritious meals. Subsequent focus group discussions allowed participants to review their photos, identify common themes, and collaboratively brainstorm strategies for improving household food safety. An abstract based on these findings was submitted for presentation at the annual meeting of the Society for Nutrition Education and Behavior.

In addition to these efforts, the project team conducted 15 key informant interviews with representatives from various sectors, including public health officials and civil society organizations. Three focus group discussions were also held with environmental health officers and community representatives to understand their roles in promoting food safety and their perceptions of relevant policies. The culmination of the project included five nominal group technique discussions, with each session comprising 8 to 10 participants who generated and ranked ideas focused on enhancing household food safety. This collaborative approach led to actionable insights centered around awareness-raising, partnership-building, infrastructure improvements, and policy changes. A manuscript summarizing these findings is currently under review at BMC Public Health, with four additional manuscripts and two reports in progress.

Capacity Building:

Nominal group technique discussions are a vital form of capacity building, as they foster collaborative engagement among participants while promoting the sharing of diverse perspectives and experiences. By facilitating structured dialogue, these discussions allowed community members to collectively identify and prioritize strategies for enhancing household food safety. The findings generated from this process are important because they reflect the real needs and insights of the community, ensuring that proposed interventions are relevant and actionable. This collaborative approach not only empowers participants by valuing their contributions but also strengthens the overall capacity of the community to address food safety challenges, ultimately leading to more effective and sustainable solutions.

Lessons Learned and Broader Application:

One key lesson learned from this experience is the importance of incorporating potential delays related to communication challenges into the project timeline. Recognizing that misunderstandings and coordination issues can arise, it is essential to build in flexibility and allocate extra time to address these hurdles. This proactive approach not only helps to manage expectations but also ensures that project activities can proceed smoothly, ultimately leading to more successful outcomes. By

planning for these contingencies, teams can better navigate complexities and maintain momentum throughout the project lifecycle.

Publications and Presentations:

Atoloye, A., Samuel, F., Bamgbade, B., Aluko, O., Otegbayo, B., Torimiro, N., Areola, A., & Bersamin, A. (2024). Understanding Mothers' Lived Experiences Providing Safe and Nutritious Foods for Their Families in Nigeria. *Journal of Nutrition Education and Behavior.* 56: S12-S13. https://doi.org/10.1016/j.jneb.2024.05.031

Samuel, F. (2024, June 26). Using the *Our Voice* mobile app to strengthen household food safety in Nigeria [Webinar]. In *Feed the Future for Innovation Lab for Food Safety Webinar Series—Engaging and Empowering Women to Strengthen Food Safety: Lessons Learned in Bangladesh, Cambodia, and Nigeria.* Retrieved from https://ag.purdue.edu/food-safety-innovation-lab/projects/resources/engaging-and-empowering-women-to-strengthen-food-safety-lessons-learned-in-bangladesh-cambodia-and-nigeria-webinar-video

Identifying Drivers and Barriers to Adoption of Food Safety Behaviors in Cambodia, Kenya, and Nepal (Commissioned Research project – FSIL Phase II)

This is a commissioned research project awarded under FSIL's Phase II, which began on June 25, 2024.

Locations: Cambodia, Kenya, and Nepal

Description: The project will investigate food safety awareness in Cambodia, Nepal, and Kenya by assessing consumer perspectives on the risks of unsafe food consumption, factors shaping food safety behaviors, reactions to food safety policies, and willingness to pay for safer food. A key focus is understanding within-household dynamics, where responsibilities for food purchasing, preparation, and handling typically fall on specific individuals. The findings will inform the creation of national strategies to enhance consumer awareness and drive demand for safer food, while also providing valuable insights for researchers, policymakers, producers, and marketers. Additionally, the data will support future FSIL research and subawards in each of the focus countries.

Theory of Change and Impact Pathway(s): This project contributes towards Objective 1 of the FSIL TOC for Phases I and II.

Collaborators: Purdue University (U.S.), To be named (Cambodia, Kenya, and Nepal)

Achievements (Aligned with Phase II Commissioned Research Project WP Objective 1):

Given the brief performance period in FY2024, the project team prioritized identifying the most cost-effective and time-efficient survey collection methodologies. Both online and in-person approaches were assessed. However, no viable online survey provider which could deliver the required scope across the target countries and demographics was located. As a result, the team shifted its focus toward in-country partnerships to facilitate data collection. These partnerships are being actively explored to ensure the surveys can be conducted effectively, meeting the project's scope and objectives while aligning with local contexts.

Capacity Building:

None to report

Lessons Learned and Broader Application:

None to report

Publications and Presentations:

None to report

Human and Institutional Capacity Development

Short-term training

Training Location	Brief Purpose of Training	Trainees	M	F	Total
Bangladesh	Training in laboratory techniques for microorganism detection in fish	Civil society	6	4	10
Bangladesh	Training farmers on safe fish production	Smallholder producers	23	7	30
Cambodia	Scientific writing workshop	Civil society	4	16	20
Nepal	Food safety training for fresh produce growers and extension service providers in Western Nepal (Kohalpur, Lumbini Province)	Smallholder producers, government, and civil society	20	36	56
Nepal	Food safety training for fresh produce growers and extension service providers in Chitwan, Nepal (Chitwan, Bagmati Province)	Smallholder producers, non-smallholder producers, private sector, government, and civil society	37	39	76
Nepal	Food safety training for fresh produce growers and extension service providers in Pokhara, Nepal (Pokhara, Gandaki Province)	Smallholder producers, non-smallholder producers, private sector, government, and civil society	25	40	65
Nepal	Food safety training for fresh produce growers and extension service providers in Kathmandu, Nepal (Bagmati Province, Nepal)	Smallholder producers, non-smallholder producers, private sector, government, and civil society	28	47	75
Nepal	National policy consultation workshop to disseminate project findings and recommendations	Smallholder producers, non-smallholder producers, private sector, government, and civil society	91	29	120
Nigeria	Training on the *Our Voice* Discovery Tool mobile application	Civil society	0	55	55
Senegal	Train women and youth milk processors in food safety and quality standardization for processed dairy products	Smallholder producers	0	12	12
Senegal	Train laboratory technicians on proper milk sample collection and microbiological analysis	Civil society	0	2	2
Thailand	Train USAID and select government officials on foundational food safety knowledge; the impacts of food safety on	Government	15	5	20

Training Location	Brief Purpose of Training	Trainees	M	F	Total
	economics, trade, and public health; knowledge of systems and interventions that improve food safety; and how to integrate food safety across programming and in Global Food Security Strategy (GFSS) country plans.				
Total			**249**	**292**	**541**

Long-term training

Trainee Number	Sex	University	Degree	Major	Program End Date (M/Y)	Degree Granted (Y/N)	Home Country
1*	F	Purdue University	Ph.D.	Agricultural Sciences Education and Communication	May 2023	N	United States
2*	M	Purdue University	Ph.D.	Agricultural Economics	May 2023	N	United States
3**	M	Cornell University	Ph.D.	Food Science and Technology	May 2024	N	United States
4	F	Royal University of Agriculture	M.S.	Agro Industry (Food Microbiology)	December 2024	N	Cambodia
5	F	Royal University of Agriculture	M.S.	Agro Industry (Food Microbiology)	December 2024	N	Cambodia
6	F	Purdue University	M.S.	Animal Science	December 2022	Y	United States
7**	M	Purdue University	Ph.D.	Agricultural Sciences Education and Communication	June 2024	N	United States
8	F	Bangladesh Agricultural University	M.S.	Agricultural Economics	October 2022	Y	Bangladesh
9	F	Bangladesh Agricultural University	M.S.	Food Technology and Rural Industries	December 2022	Y	Bangladesh
10	F	Bangladesh Agricultural University	M.S.	Agricultural Finance and Banking	June 2022	Y	Bangladesh
11	F	Bangladesh Agricultural University	M.S.	Microbiology and Hygiene	October 2022	Y	Bangladesh
12	M	Bangladesh Agricultural University	Ph.D.	Agricultural Economics	December 2024	N	Bangladesh
13	F	National School of Agriculture	M.S.	Animal Production	May 2023	Y	Senegal
14**	M	National School of Agriculture	M.S.	Value Chain Development, Agriculture & Agribusiness Entrepreneurship	December 2023	N	Senegal
15	F	Polytechnic School of Dakar	M.S.	Engineering in the Food Industry	March 2023	Y	Senegal
16**	M	National School of Agriculture	M.S.	Value Chain Development, Agriculture & Agribusiness Entrepreneurship	November 2022	N	Senegal

17	F	National School of Agriculture	M.S.	Value Chain Development, Agriculture & Agribusiness Entrepreneurship	December 2023	Y	Senegal
18	F	Institute of Technology of Cambodia	M.S.	Agri-Industrial Engineering	September 2023	Y	Cambodia
19**	F	KEMRI	M.S.	Medical Microbiology	December 2023	N	Kenya
20**	M	KEMRI	M.S.	Medical Microbiology	December 2022	N	Kenya
21	F	Purdue University	Ph.D.	Agricultural Economics	August 2026	N	Senegal
22	F	Bangladesh Agricultural University	Ph.D.	Microbiology	December 2024	N	Bangladesh
23	F	Bangladesh Agricultural University	M.S	Food Science	December 2022	Y	Bangladesh
24	F	Bangladesh Agricultural University	M.S	Agricultural Economics	March 2024	Y	Bangladesh
25	F	Bangladesh Agricultural University	M.S	Microbiology	March 2024	Y	Bangladesh
26	F	Bangladesh Agricultural University	M.S	Agricultural Economics	March 2024	Y	Bangladesh
27	M	University of Nairobi	Ph.D.	Food Safety and Quality	December 2024	N	Kenya
28	F	University of Dhaka	M.S.	Sociology	August 2022	Y	Bangladesh
29	F	Purdue University	Ph.D.	Animal Science	May 2024	Y	United States
30	F	University of Nairobi	Ph.D.	Food Science and Technology	September 2026	N	Kenya
31	F	University of Nairobi	M.S.	Food Science and Technology	December 2024	N	Kenya
32	F	University of Nairobi	M.S.	Food Science and Technology	September 2025	N	Kenya

*Supported by FSIL for the fall 2020 semester

**Did not complete degree through FSIL

Environmental Mitigation and Monitoring Plan (EMMP)

Per the FSIL EMMP, activities requiring specific mitigation and monitoring efforts include 1) food safety research on raw food materials contaminated with biological and chemical contaminants; and 2) clinical (medical) evaluations and people-based surveys. During FY2024, FSIL continued to mitigate risks associated with these activities.

Each subaward's PI is responsible for uploading the required Institutional Review Board (IRB) and Institutional Biosafety Committee (IBC) documentation to the Piestar DPx platform for review by FSIL's Director and Associate Director. Once the documentation is approved by FSIL, it is submitted to the Agreement Officer's Representative (AOR) for review. In addition, FSIL conducts an internal EMMP audit semiannually to ensure all required documentation has been submitted per each subaward's activities.

For laboratory-based research, each subaward PI is responsible for documenting laboratory protocols, training personnel, and conducting regular on-site or virtual monitoring of laboratory sites to ensure safety protocols are followed.

Subaward	**IBC Approval**	**Laboratory Standard Operating Procedures**	**Lab Safety Training Forms**	**Updated FY2024 Lab Safety Monitoring Forms**
Bangladesh long-term	Submitted to AOR	Submitted to AOR	Submitted to AOR	Submitted to FSIL ME
Cambodia long-term	Submitted to AOR	Submitted to FSIL ME (new for WGS)	Submitted to FSIL ME (new for WGS)	N/A
Kenya long-term – Phase I	Submitted to AOR	Submitted to AOR	Submitted to AOR	N/A
Kenya long-term – Phase II	Submitted to FSIL ME	Submitted to FSIL ME	Submission in FY2025	N/A
Nepal short-term	Submitted to AOR	Submitted to AOR	Submitted to AOR	N/A
Nigeria short-term	Submitted to AOR	Submitted to AOR	Submitted to AOR	N/A
Senegal long-term	Submitted to FSIL ME	Submitted to FSIL ME	Submitted to AOR	Submitted to FSIL ME

For people-based surveys or human subjects research, each PI is responsible for utilizing their respective IRB to obtain approval or exemption of the proposed activities.

Subaward	**IRB Approval/Exemption**
Bangladesh long-term	Submitted to AOR
Cambodia long-term	Submitted to AOR
Kenya long-term Phase I	Submitted to AOR
Kenya long-term Phase II	Submitted to FSIL ME
Nepal short-term	Submitted to AOR
Nigeria short-term	Submitted to AOR
Senegal long-term	Submitted to AOR

All forms that were submitted to the FSIL ME during FY2024 will be submitted to the AOR prior to November 2024.

Open Data Management Plan

FSIL continues to partner with Purdue University's Ag Data Services to ensure that research teams have access to technical support related to data management and sharing. At project onset, Ag Data Services works with each subaward to develop a data management plan. As project objectives are completed, Ag Data Services supports researchers in cleaning, organizing, and sharing their datasets.

In FY2024, Ag Data Services hosted data management virtual office hours for subawards to connect and discuss specific data-related questions. As projects entered the final phase of the project life cycle and finalized their datasets, Ag Data Services conducted frequent one-on-one meetings to ensure all datasets were completed and uploaded to the Harvard Dataverse and USAID's Development Data Library (DDL).

Governance and Management Entity Activity

Activity 1.1: Create and Maintain Effective Management Structures and Practices That Promote the Success of Active FSIL Projects

Throughout FY2024, FSIL implemented robust management structures designed to support and monitor the progress of its active projects. Monthly meetings were held with each project team to review updates, address challenges, and outline strategies for project closure. These regular touchpoints allowed FSIL to offer timely technical guidance, such as laboratory training in Bangladesh and assistance in designing sample collection and laboratory protocols for Kenya's data collection efforts.

FSIL also provided strategic support to facilitate the translation of research outcomes into actionable impacts in both public and private sectors. This includes the ongoing development of policy briefs aimed at influencing food safety and consumer awareness initiatives. Field visits were conducted by FSIL management to project sites in Bangladesh, Kenya, and Nepal to oversee activities, engage with USAID Missions, and provide direct support to project teams.

The FSIL FY2024 annual meeting was convened in Cambodia, serving as a collaborative platform for USAID, the advisory committee, FSIL teams, and local partners. The event featured interactive panel discussions, showcasing local capacity-building efforts through engagement with USAID officials, collaborators, and local farmers.

In line with the commitment to supporting MSI-led projects in Nepal and Nigeria, FSIL's Management Entity maintained administrative oversight and contracting for all seven U.S. and foreign subawards associated with these projects. Additionally, FSIL collaborators provided updates on their activities related to the EMMP in semi-annual reports, with oversight and approval from both FSIL and USAID.

Activity 1.2: Develop Robust Monitoring, Evaluation, Learning (MEL), Communication, and Open Data Platforms

FSIL continued leveraging the Piestar DPx platform to monitor project progress, with teams submitting semi-annual reports on their achievements, challenges, and progress toward work plan objectives and indicator targets. In FY2024, the focus for most projects was on concluding data collection and analysis as part of the project wrap-up phase. Purdue's Ag Data Services team offered support to ensure each project team properly formatted and uploaded their data to the Harvard Dataverse and USAID's DDL, adhering to FSIL's Open Data Management Plan.

FSIL's communication efforts reached a broad audience, with 22 unique articles posted on Agrilinks and the FSIL website. These posts highlighted peer-reviewed publications, capacity-building activities, and key insights from principal investigators (PIs) from both in-country institutions and minority-serving institutions. Additional content aligned with Agrilinks' monthly themes. FSIL maintained an active social media presence, with a combined following of 1,953 across LinkedIn and X (formerly Twitter), marking a significant increase of 770 followers from FY2023. The FSIL ME also distributed regular e-newsletters and hosted two webinars in June 2024, focused on Social Behavior Change in Food Safety and Engaging and Empowering Women to Strengthen Food Safety, with 384 registrants across both events.

Activity 1.3: Engage FSIL Advisory Committee and Technical Experts for Project Guidance and Support

The FSIL Advisory Committee and Technical Experts played an integral role in FY2024, providing project teams with valuable feedback and guidance during the FSIL annual meeting. This interaction helped project leaders assess their achievements and explore future research opportunities. With the conclusion of FSIL Phase I on June 24, 2024, the duties of the advisory committee members and technical experts were formally completed. As FSIL entered Phase II, the structure and roles of external collaborators were redefined to align with the evolving goals of the initiative.

Activity 1.4: Implement Small Research Projects to Complement Existing Subawards and Scope Future Research

Under Phase II of FSIL, a short-term commissioned research project was launched on June 25, 2024, targeting food safety awareness in Cambodia, Nepal, and Kenya. The project is investigating consumer perspectives on the risks associated with unsafe food consumption, factors shaping food safety behaviors, responses to food safety policies, and willingness to pay for safer food. A central focus is on understanding household dynamics, particularly how food purchasing, preparation, and handling responsibilities are distributed among household members.

The findings from this research will inform the development of national strategies aimed at enhancing consumer awareness and generating demand for safer food. The data will offer actionable insights for researchers, policymakers, producers, and marketers, and will also serve as a foundation for future FSIL research initiatives and subawards in each country.

Other Topics

FSIL awarded a 5-year extension

In FY2024, FSIL successfully concluded its first five-year period with USAID on June 24, marking the completion of Phase I. Subsequently, FSIL was awarded a five-year extension for Phase II. In this phase, FSIL will consolidate resources and activities in three focus countries: Cambodia, Kenya, and Nepal. While all three countries possess food policy landscapes conducive to advancing food safety, they face challenges such as limited consumer awareness and demand for safer food, insufficient education for producers and vendors on safe food production practices, a lack of recognition of food safety as a public health priority, and inadequate surveillance and enforcement infrastructure.

In Phase II, FSIL will support research that fills key evidence gaps, increases food safety awareness, and builds capacity to motivate consumer, government, and private sector action that strengthens food safety systems. The research will increase consumer awareness of and demand for safer food, empower governments to generate and use food safety data, and motivate the private sector to adopt safe food production practices.

Graduate students supported to attend International Association for Food Protection (IAFP) Meetings

With FSIL support, a total of six students and researchers attended meetings of the International Association for Food Protection. Three students from Bangladesh and Senegal and one Nigerian researcher presented posters at the IAFP 17th Dubai International Food Safety Conference. Two Cambodian graduate students were supported to attend the 2024 IAFP Annual Meeting in Long Beach, California, where they presented their research findings on microbial assessments of *E. coli* and *Salmonella enterica* along the vegetable value chains in Battambang and Siem Reap, Cambodia. The food safety research conferences convened by IAFP provide significant opportunities for professional development and knowledge exchange. The activity directly supported Objective 2 in the FSIL TOC by building local research capacity. Participants took full advantage of opportunities to connect with colleagues from other countries and broaden their knowledge of food safety research and approaches:

> My participation in the International Dubai Food Safety Conference was an exceptional, valuable, and enriching experience. The knowledge gained, contacts established, and inspiring ideas will serve as essential guides for my future actions in the field of food safety. I am grateful for the opportunity and enthusiastic about contributing further to this crucial cause. The poster presentation facilitated fruitful discussions with several participants, providing an opportunity to engage in enriching conversations about the dairy food safety situation in their respective countries. For instance, interacting with representatives from major milk-producing countries such as Pakistan was particularly rewarding, where crucial topics such as the influence of cattle breeds in dairy production and hygiene standards in dairy industries were discussed. (M. Diedhiou, National Higher School of Agriculture of Thiès)

> There were eminent speakers, engaging conversations, and networking that took place throughout the three-day event. One of my key takeaways was that in addressing food safety, a risk-based, evidence-driven, people-centered, forward-looking approach would be more acceptable by the food producer and effective in protecting consumer health. (N. Torimiro, Obafemi Awolowo University)

> As an economist, I didn't have much knowledge about food safety practices, but this conference broadened my outlook and inspired me to do more integrated research in the future. This includes areas such as production, pest and disease control, storage, packaging, marketing, trade facilitation and import control, processing, management and coordination, evaluation through audit and inspection, food waste and loss, antimicrobial resistance, food system sustainability, technology, and innovation. (F. Dewan, Bangladesh Agricultural University)

Food safety workshop

FSIL received a buy-in from USAID to conduct a series of food safety workshops for USAID Mission staff and other key stakeholders. Each three-day, hands-on workshop will provide a comprehensive introduction to food safety risks and strategies to strengthen food safety practices and policies. In addition, the workshops will prepare participants to identify opportunities to integrate food safety into Feed the Future Innovation Lab programs. The first workshop was held in Bangkok, Thailand, in August 2024. The remaining workshops are scheduled for FY2025 and are outlined in the Future Directions section below.

Food Safety Sector Environmental Guidelines

FSIL has received a buy-in from USAID to develop Food Systems: Food Safety Sector Environmental Guidelines (SEG). These guidelines will promote environmental compliance and sustainability across USAID projects by providing clear and accessible information on food safety risks, nutritional impacts, and preventive measures. The SEG will serve as a practical tool for USAID staff and implementing partners, helping them integrate food safety considerations into project planning and execution while ensuring alignment with the agency's environmental regulations and sustainability objectives.

Next-generation pathogen detection: Sequencing wastewater in Kenya to establish baseline foodborne pathogen prevalence information

In FY2023, FSIL collected 10 samples for a preliminary trial of metagenomic sequencing to detect food pathogens from wastewater streams. In FY2024, FSIL completed sequencing and analysis of the 10 samples, determining methodological improvements for a larger proof of concept study that will occur in Nairobi, Kenya, during FY2025. During FY2024, FSIL engaged KEMRI to conduct sample collection for the larger study as a component of the Kenya long-term Phase II project. Through contracting and project initiation, the project received IRB approval and other research permits required to conduct the work. FSIL also received permitting from the United States Animal and Plant Health Inspection Service to import samples to the United States for sequencing at Cornell University. Additionally, KEMRI engaged the Nairobi City Water and Sewerage Company (NCWSC), a government entity that manages wastewater infrastructure in Nairobi, to consult and aid in sample collection for the project. NCWSC has access to the sewer network in Nairobi and will provide KEMRI and FSIL with localized sampling guidance and area descriptions and access to sampling at key junctions in the sewer network. NCWSC has previously assisted in wastewater sampling for COVID-19 during the coronavirus pandemic; they will be a key government partner for completing this work in FY2025.

Raising awareness of microbial food safety risks and mitigation opportunities

All FSIL projects continue to place a strong emphasis on increasing awareness of microbial food safety risks and measures to mitigate risks. Because the microorganisms that cause foodborne illness are not detectable to the naked eye and often do not alter a food's appearance or odor, consumers are often unaware of the prevalence of foodborne pathogens or of the connection between foodborne pathogens and illness. FSIL projects identify gaps in food safety awareness and host workshops and create outreach materials to address them. These awareness initiatives target producers, distributors, consumers, and — importantly — government officials, whose awareness is critical to implementing policies that will enable long-term, sustained improvements in food safety through infrastructure investments and policy. Key highlights from FY2024 are as follows:

***Bangladesh*:** The team's dissemination event in May 2024 attracted 150 stakeholders for presentations on project findings. Key insights included the following: Bacterial loads in fish raised using GAqPs were lower than those raised using conventional practices; enhanced food safety knowledge among producers may lead to better adherence to GAqPs; and consumers demonstrated a preference for fish produced in safer environments, indicating a willingness to pay a premium for GAqP-certified fish.

***Nepal*:** The project team hosted a dissemination and policy consultation workshop for 120 participants, including federal and local government officials, producers, and representatives from civil society. The workshop shared results from studies on *E. coli* levels in water used for washing produce and its implications for food safety. Additionally, over 500 copies of the food

safety manual for produce growers developed by the project were distributed to growers and extension agents. These manuals offer accessible information on fresh produce safety and good agricultural practices. A Nepali version of the manual will be released in FY2025.

***Nigeria*:** Using a citizen science approach, fifty-five mothers from five areas in Ibadan Metropolis were recruited to document food safety barriers in their homes and communities over five days using the *Our Voice* mobile application. Following this data collection, the mothers convened with civil society organizations, healthcare personnel, and representatives from the Market Women Association to review the findings and discuss strategies to address the identified issues. Project researchers noted that the experience increased women's awareness of household food safety risks and provided a platform for them to share their practical strategies and practices related to food storage, preservation, and household hygiene.

Senegal: In April 2024, Dr. Abebe visited Senegal to conduct capacity-building training aimed at strengthening the dairy sector. The training provided laboratory personnel with skills in milk sample collection and microbiological quality analysis. Also in April, a specialized training was held at the Institut de Technologie Alimentaire (ITA) for twelve milk processing units, focusing on improving food safety and standardizing the quality of processed dairy products. The session specifically targeted women and youth processors, equipping them with the knowledge needed to enhance the safety and quality of their products. To address gaps identified in previous surveys, ITA selected one mini-dairy to participate in a week-long, in-depth training on good manufacturing practices (GMPs) and product development, further supporting their growth and capacity to produce safe dairy products.

Management Entity Presentations

Oliver, H.F. (2023, November). Twenty years in food safety research and I still get sick - A few thoughts on why [Lecture]. Purdue University College of Agriculture Research Award. West Lafayette, IN, USA.

Oliver, H.F. (2023, November). Food safety in developing economies: Reflecting on progress, envisioning the road ahead [Webinar]. *National Academies of Science Food Forum 30th Anniversary*. Virtual.

Oliver, H.F. (2024, May). Feed the Future Innovation Lab [Lecture]. University of Florida. Virtual.

Oliver, H.F. (2024, September). My sustainability: Improving the human condition: One prevented case of diarrhea at a time [Lecture]. Purdue University. West Lafayette, IN, USA.

Oliver, H.F., Worobo, R.W. (2024, August). Food Safety Training [Workshop presentation]. USAID/FSIL Food Safety Training Course. Bangkok, Thailand.

Sogin, J. H. (2024, February). Introduction to the Feed the Future Innovation Lab for Food Safety [Lecture]. College of Saint Benedict and Saint John's University. Saint Joseph, MN.

Sogin, J. H. (2024, February). Investigating microorganisms across macro distances: An intro to FSIL [Seminar]. College of Saint Benedict and Saint John's University. Saint Joseph, MN.

Worobo, R. W. (2024, April). Data and evidence needs for informed decision-making on ensuring fresh produce in Nepal [Panel discussion]. Fruit and Vegetable Food Safety: Evidence to Support Policy Action. Kathmandu, Nepal.

Worobo, R. W. (2024, September). Food safety & its role in food security [Workshop presentation]. Neogen Food Safety Workshop, Virtual.

Worobo, R. W. (2024, July). International food safety and the Food Safety Innovation Lab [Conference presentation]. Institute of Food Technologies Annual Conference, Chicago, IL.

Issues

Kenya

In FY2023, the lead PI at The Ohio State University (OSU) transitioned to a new institution, prompting OSU to relinquish the award effective August 31, 2023. This decision also resulted in the cancellation of the second-tier subawards that OSU held with collaborating institutions, resulting in a temporary pause in all project activities. This presented FSIL with an opportunity to prioritize locally led initiatives by strengthening its partnership with the Kenya Medical Research Institute (KEMRI) and the University of Nairobi. Both institutions, which had already obtained initial IRB approval for the work, remained committed to advancing the project. By the third quarter of FY2024, USAID approved the realigned scope of work (SOW) and budget for Kenya Phase II. KEMRI and the University of Nairobi were fully contracted directly with Purdue University by June 2024.

Although FSIL Phase I officially ended on June 24, 2024, just as project activities were being initiated, FSIL identified avenues to expand the project's impact under FSIL's Phase II. Despite delays caused by the lengthy approval and contracting processes, both KEMRI and the University of Nairobi have continued to make considerable progress in preparing for data collection, ensuring that the project will resume once the outstanding budget realignment is approved by USAID.

Future Directions

Management Entity

FSIL's Management Entity (ME) will focus on strengthening partnerships by identifying a new cohort of advisory committee members for Phase II. With input from the advisory committee, USAID, and in-country stakeholders, the FSIL ME will develop an RFA for competitively funded awards aligned with FSIL's Phase II research priorities. A comprehensive communications strategy will be designed to attract diverse participation, particularly from in-country research institutions and minority-serving institutions. The RFA application process will be facilitated through the Piestar RFx platform, with an expected release in the second quarter of FY2025. Advisory Committee members and USAID will support the selection process for these competitive awards, which are slated to begin in the fourth quarter of FY2025. Additionally, FSIL will continue its monthly one-on-one meetings with existing subawardees to ensure smooth project execution.

Sector Environmental Guidelines

FSIL will lead the development of the first Food Systems: Food Safety Sector Environmental Guidelines (SEG). These guidelines aim to enhance environmental compliance and sustainability across USAID projects by providing practical guidance on managing food safety risks, assessing nutritional impacts, and implementing preventive measures. The SEG will serve as a critical resource for USAID staff and implementing partners, helping them integrate food safety considerations into project planning while ensuring alignment with USAID's environmental and sustainability goals.

Food Safety Workshops

In FY2025, FSIL will conduct an additional four food safety workshops for USAID Mission staff and implementing partners in selected Feed the Future countries and Washington, D.C. These workshops will provide foundational knowledge of food safety, its economic and public health impacts, and practical approaches to incorporating food safety into agricultural activities. Participants will include representatives from USAID Missions and local government agencies. Planned locations for the additional workshops include Tanzania, Ghana, Colombia, and Washington, D.C.

Whole Genome Sequencing

As one component of FSIL's ongoing food safety research capacity strengthening efforts, FSIL plans to host a whole genome sequencing (WGS) workshop in Q2 of FY2025. WGS is the new global standard used to characterize food pathogens, track their transmission, and identify outbreaks. WGS research capacity, which is lacking across FSIL's focus countries, is a key tool for countries to strengthen their food safety systems and participate in global food safety efforts. To build WGS capacity in FSIL's focus countries, FSIL plans to host a workshop in partnership with Mahidol University in Thailand for current FSIL-funded project partners and potential partners for future FSIL Phase II projects. The WGS workshop will provide training for 6 to 12 participants from universities and public institutions located in FSIL focus countries. FSIL will identify participants, with assistance from current partner organizations, to attend the workshop in Nakhon Pathom, Thailand, and will fully cover their travel expenses.

Long-Term Subawards

- **Bangladesh:** The project has been extended until December 2024 to allow two graduate students to complete their degrees and to finalize the economic analysis of the costs of producing safer fish. The project team will also engage with the Department of Fisheries, Bangladesh Food Safety Authority, and the National Planning Commission to integrate GAqPs into national policies.

- **Cambodia:** The project was completed in August 2024. The team is now focused on preparing publications based on the project's findings.

- **Kenya:** The project will concentrate on microbial sample collection and analysis across various production, processing, and retail sites for broilers, spent laying hens, and indigenous birds. Samples will be tested for *Salmonella* and *Campylobacter* using both culture-based and sequencing techniques. Results will inform future training, research priorities, and policy recommendations, with findings shared through peer-reviewed publications. Additionally, in partnership with Nairobi City Water and Sewerage Company, wastewater samples will be analyzed via metagenomic sequencing to determine which food pathogens are present in different parts of the city. The wastewater sequencing will serve as a proof-of-concept study for determining food pathogen risk in places with limited public health data.

- **Senegal:** The project has been extended to December 2024 to complete data analysis on the microbiological quality of milk products in the Zones of Influence and finalize data analysis from the socio-economic survey. Educational posters on food safety practices, focused on preventing disease transmission and improving milk handling, will be distributed to actors across the dairy value chain.

Short-Term Subawards

- **Nepal:** The project was extended until January 2025 to finalize the translation, printing, and dissemination of the grower's manual in both English and Nepali. Team members are also preparing publications.

- **Nigeria:** Although the project ended on May 31, 2024, the team continues to work on a story map, and four additional manuscripts and two reports focusing project activities including the *Our Voice* data, key informant interviews, and an analysis of household surveys, anthropometrics, and environmental sanitation data.

Commissioned Research – FSIL Phase II

The team will conduct surveys in Cambodia, Kenya, and Nepal to identify the key drivers of behavioral changes leading to safer food systems. The data collected will guide future research initiatives to enhance food safety in these regions.

Appendix A – List of Awards to U.S. Partners

Project Name: Feed the Future Innovation Lab for Food Safety (Management Entity)
Project Dates: 06/25/2019 to 06/24/2029
Institution: Cornell University
Funding:

- FY2024: $100,000
- Project to date: $1,681,929

Project Name: Enhancing Food Safety in Fish and Chicken Value Chains of Bangladesh (Bangladesh Long-Term Subaward)
Project Dates: 10/01/2020 to 12/31/2024
Institution: Texas State University
Funding:

- FY2024: $365,683
- Project to date: $678,022

Project Name: Reducing Foodborne Pathogen Contamination of Vegetables in Cambodia: Innovative Research, Targeted Interventions, and Impactful, Cambodian-Led Engagement (Cambodia Long-Term Subaward)
Project Dates: 10/01/2020 to 8/15/2024
Institution: Kansas State University
Funding:

- FY2024: $83,385
- Project to date: $666,534

Project Name: Reducing Foodborne Pathogen Contamination of Vegetables in Cambodia: Innovative Research, Targeted Interventions, and Impactful, Cambodian-Led Engagement (Cambodia Long-Term Subaward)
Project Dates: 10/01/2020 to 8/15/2024
Institution: Purdue University
Funding:

- FY2024: $14,427
- Project to date: $67,746

Project Name: Food Safety Capacity Building in Senegal: Enhancing Resilience of the Dairy Value Chain by Leveraging Public-Private Partnerships (Senegal Long-Term Subaward)
Project Dates: 10/01/2020 to 12/31/2024
Institution: University of Georgia
Funding:

- FY2024: $0
- Project to date: $599,999

Project Name: Drivers of Safer Food Production and Consumption in Nepal: Understanding the Adoption of Food Safety Practices and Consumer Consciousness in Fresh Produce (Nepal Short-Term Subaward)
Project Dates: 03/01/2022 to 5/31/2024
Institution: Tennessee State University
Funding:

- FY2024: $0
- Project to date: $163,477

Project Name: Drivers of Safer Food Production and Consumption in Nepal: Understanding the Adoption of Food Safety Practices and Consumer Consciousness in Fresh Produce (Nepal Short-Term Subaward)
Project Dates: 03/01/2022 to 5/31/2024
Institution: Arizona State University
Funding:

- FY2024: -$457

- Project to date: $37,110

Project Name: Household-level Food Safety Risk and Community Capacity to Monitor and Mitigate Foodborne Illness in Nigeria (Nigeria Short-Term Subaward)
Project Dates: 05/01/2022 to 5/31/2024
Institution: University of Alaska Fairbanks
Funding:

- FY2024: $81,826
- Project to date: $142,210

Project Name: Household-level Food Safety Risk and Community Capacity to Monitor and Mitigate Foodborne Illness in Nigeria (Nigeria Short-Term Subaward)
Project Dates: 07/01/2022 to 5/31/2024
Institution: Utah State University
Funding:

- FY2024: -$16,465
- Project to date: $52,307

Project Name: Identifying Drivers and Barriers to Adoption of Food Safety Behaviors in Cambodia, Kenya, and Nepal (Commissioned Research project – FSIL's Phase II)
Project Dates: 09/01/2024 to 7/31/2025
Institution: Purdue University
Funding:

- FY2024: $301,615
- Project to date: $301,615

Appendix B – Success Stories

Success Story 1: Study Finds Water Quality a Priority for Food Safety in Nepal

Nepal – February 28, 2024

A splash of irrigation water in a field, a rinse at the market, a thorough wash of salad vegetables before a meal: all three are moments when water contaminated with foodborne pathogens can turn nutrient-rich produce into a vehicle for foodborne illness. A nationwide study of contamination in the water sources used by growers, vendors, and consumers in Nepal underscores the pressing need for policies and programs to increase the safety of water used in Nepal's food systems.

The study, funded by the Feed the Future Innovation Lab for Food Safety, involved a nationwide sampling effort in five metropolitan areas as well as ten vegetable production hubs across all seven of Nepal's provinces. In total, 394 randomly selected water samples were collected, including 156 from consumer households and 238 from growers or vendors. The presence of *Escherichia coli* (*E. coli*) was used as an indicator of contamination risk in water.

The findings painted a stark picture: Overall, 59% of the samples were contaminated with *E. coli*. Levels of contamination differed among the types of water sources used by producers. Surface water sources, such as rivers, streams, and kholas (small streams with stagnant or moving water), had an *E. coli* presence rate of 88%. The prevalence rate of *E. coli* in stored water and tap water were 66% and 58%, respectively. The lowest prevalence (29%) was present in hand-pump water, which is sourced from underground aquifers.

"It seems that the growers use different water sources for washing the produce, including stagnant or moving water on the surface, tap water, and underground water," said Rabin Aryal, a team member involved in the field study based at Nepal's Agriculture and Forestry University. "Notably, the tap water is quite contaminated compared to water sourced from underground."

Consumers were found to use a variety of water sources to wash fresh produce, including water stored in tanks or containers, tap water, pump water, water purchased from tank suppliers, and bottled drinking water. Overall, consumer water supplies had a 67% *E. coli* prevalence rate with no significant differences by source type.

Based on the data, the research team suggested five priority areas for action:

- Public and private sector investment in infrastructure to improve consumer and producer access to clean, safe water
- The development and adoption of water testing guidelines, food safety practices, and regulations to strengthen food safety
- Increased education and outreach to enhance the awareness of growers, consumers, vendors, and processors of the health risks associated with contaminated water
- Incentivization of the adoption of safer food- and water-use practices in food supply chains
- Robust monitoring to enforce regulations for safer water use in food systems

"Our data shows that water quality is one of the important challenges for food safety in Nepal," said Aditya Khanal, project lead and associate professor in the Department of Agricultural and Environmental Sciences at Tennessee State University. "By taking action on water quality, we have a real opportunity to contribute to preventing foodborne illnesses."

Photo caption: Bala Sharma, lab technician at Nepal's Agriculture and Forestry University, samples water used to wash carrots for *E. coli* testing. (Photo credit: Bhattacharya Productions)

Success Story 2: Giving Voice to Citizen Scientists on Household Food Safety in Nigeria

Nigeria – June 28, 2024

In Nigeria, foodborne illness is a significant public health issue, causing over 200,000 deaths a year and contributing to a childhood stunting rate of 37% in children under the age of five. To develop strategies to address food safety at the household level, researchers funded by the Feed the Future Innovation Lab for Food Safety (FSIL) partnered with Nigerian mothers to understand the challenges they face in providing safe, nutritious meals for their families.

The team of researchers, based in Nigeria and the United States, recruited 55 mothers from five local government areas in Ibadan. In the first phase, participants received daily prompts through Stanford Medicine's *Our Voice* Discovery Tool app to provide information about their practices in important domains of food safety, including food storage, food purchases, meal preparation, eating, and household hygiene. The mothers took photos and captured narrative data about anything they noted would contribute to food safety, such as purchasing food from vendors who keep their products securely covered, as well as obstacles they faced, such as maintaining cleanliness in communal cooking spaces.

"Our findings from their lived experiences using *Our Voice* and stakeholder interviews suggest that the drivers of food safety – and potentially malnutrition – span all levels of the social-ecological model," said Abiodun Atoloye, assistant professor of nutrition science at Utah State University and a FSIL Nigeria project co-PI. "Individual-level food safety knowledge, behavior, and practices are only part of the solution."

The *Our Voice* data identified several systemic challenges. Some arose within the household, such as shared facilities for meal preparation and insufficient financial resources. Other food safety barriers involved infrastructure and governance: power outages, poor water and sanitation infrastructure, and non-compliance with food safety regulations at the policy level.

"The daily prompts served as an eye-opener for the women to identify risks as they relate to food safety practices in their households," said Folake Samuel, project co-PI and professor of public health at the University of Ibadan. "The process also fostered woman-to-woman learning, as the discussions provided a platform for mothers to share their practical and relatable personal values, strategies, practices and experiences as they relate to food storage, preservation, and hygiene."

In the second phase of the study, the mothers met to identify common themes around strengths, resources, and challenges for each daily prompt and to identify potential solutions. Priorities included food safety training for vendors, environmental sanitation enforcement, and improved access to essential communal amenities. These recommendations were shared at a July 2024 meeting where selected mothers, health care providers, community development personnel, representatives from the State Ministry and civil societies, and community-based organizations collaborated to prioritize actions to strengthen food safety.

Many of the *Our Voice* participants expressed interest in participating in future studies, motivated by their newfound understanding of food safety risks and the desire to contribute to improving their community's health and well-being.

"Over the course of this project, strong connections were made that have the potential to drive positive changes," Atoloye said.

Photo caption: Researchers and citizen scientists discuss food safety challenges identified using the *Our Voice* Discovery Tool app and priority actions to strengthen food safety in Ibadan, Nigeria. (Photo credit: Folake Samuel)

Success Story 3: Empowering Milk Processors to Reduce Foodborne Illness in Senegal

Senegal — July 20, 2024

Following in her mother's footsteps as the leader of a milk and yogurt processing unit, Faty Sow's goal is to grow the business while providing safe dairy products for consumers in Senegal's Matam region. Small-scale dairy producers and processors like Sow play an important role in local food security, but without preventative food safety practices in place, milk products can spread microbial foodborne pathogens including *E. coli*, *Listeria*, and *Salmonella*.

Sow recently attended a food safety training for female and youth dairy processors at the Institut de Technologie Alimentaire (ITA). The workshop taught ambitious innovators like Sow the practices they should use to protect their products' safety and quality, including sanitation, hygiene, pasteurization, and new product development.

"The training is valuable, as I got more guidance and management of food safety in the whole process for high-quality milk and derivate products," said Sow. "The various products developed during the training will help position the processing units to get more markets, especially supermarkets and stores, where our products are not accessed yet."

The training was offered through a project funded by the Feed the Future Innovation Lab for Food Safety focused on strengthening the safety of fresh milk and dairy products produced in Senegal. Protecting the microbial quality and safety of dairy products can be challenging as milk travels through Senegal's supply chain of small farms, aggregation sites, artisanal processing facilities, and transport from rural areas to urban centers. Dairy is a highly perishable product: Without strategic interventions during processing and temperature control during storage and transport, it can quickly become hazardous. This recent training was one of several the project has offered over the past three years. To date, 165 small-scale dairy producers and processors have participated in programs to raise awareness of food safety risks and learn practices to mitigate them.

In addition, researchers have been collecting baseline data to inform dairy safety practices, policy, and future outreach. Key data includes pathogen prevalence on farms and in small dairy processors; the project's efforts to strengthen laboratory research capacity have enabled partners to perform genetic analyses to isolate, characterize, and identify priority organisms. Researchers are also assessing current food safety knowledge, attitudes, and practices in the dairy value chain. The focus group discussions and surveys with owner-operators of mini-dairies and the households that supply them with milk will provide further insight into existing challenges and future directions.

By targeting food safety knowledge gaps, strengthening local food safety research capacity, raising food safety awareness, and delivering food safety training, the program is empowering milk producers and processors —like Faty Sow — to contribute to a safe local milk supply that not only supports food security and nutrition but also creates economic opportunity. The project is led by Manpreet Singh, department head and professor of food science and technology at the University of Georgia, in partnership with colleagues at the Senegalese Institute of Agricultural Research, Conseil National du Développement de la Nutrition, ITA, and Tuskegee University.

Photo caption: Faty Sow, pictured far right, participated in a food safety training for female and youth dairy processors at the Institut de Technologie Alimentaire. (Photo credit: Institut de Technologie Alimentaire)

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