



FEED THE FUTURE

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

Feed the Future Innovation Lab for Fish

Semi-Annual Report October 1, 2020 – March 31, 2021

Cooperative Agreement 7200AA18CA0030



USAID
FROM THE AMERICAN PEOPLE



MISSISSIPPI STATE
UNIVERSITY™

GLOBAL CENTER FOR
AQUATIC FOOD SECURITY

Feed the Future Innovation Lab for Fish

Semi-Annual Report October 1, 2020 – March 31, 2021

Cooperative Agreement 7200AA18CA0030

Prepared for:

Agreement Officer's Representative (AOR)
Feed the Future Innovation Lab for Fish (Fish Innovation Lab)
Bureau for Resilience and Food Security (RFS)
United States Agency for International Development (USAID)

Prepared by:

Mississippi State University
Global Center for Aquatic Food Security
Mississippi State, Mississippi 39762

This publication 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 Innovation Lab for Fish and do not necessarily reflect the views of USAID or the United States Government.

Progress Made by Fish Innovation Lab Activities During the Reporting Period

See Appendix 1 for details of accomplishments.

Objective 1: Improve Aquaculture and Fisheries Productivity

Activity 1.1: Aquaculture and Rural Communities: Farm Diversification Strategy Through Integrated Agriculture-Aquaculture Systems and Nutrition-Sensitive Value Chains for Better Nutrition Outcomes

The team established six adaptive research plots that are near 90% completion and ready for stocking with fish and rice planting. Ten wetland maps of the study areas were produced (including the flooding regimes, land use patterns, and vegetation patterns) using global positioning system (GPS). A report of the preliminary rural community appraisals for the six activity sites in the two states was produced and finalized. Data on situational analyses of nutrition status, gender, and youth involvement was collected. Socioeconomic questionnaires directed to the target groups and stakeholders were developed, and 20 enumerators were trained by the socioeconomic team on questionnaire administration to the six selected activity communities in both states.

Activity 1.2: No Longer Bugged by Feed Costs: Farming Insects as Sustainable and Scalable Aquaculture Feedstock to Improve Catfish (*Clariidae*) Producers' and Consumers' Livelihoods Towards Food Security in Nigeria

To understand the relevant population and develop survey sampling methods, the University of Ibadan team communicated with local contacts, including the program managers of the Ebonyi and Cross River Agricultural Development Programs, about how fish farmers are organized in the Nigerian target states. A pilot fish-farmer survey was developed with expected pilot survey implementation and subsequent survey instrument revision in the next six weeks. Full survey implementation will occur by the end of the calendar year. The survey/questionnaire is being programmed into KoBo Toolbox, which works with Android-based tablets for electronically administered surveys.

Activity 1.3: Improving Efficiency in the Nigerian Aquaculture Sector by Employing Lean Production Systems

Planning and preparation for the lean subject-matter experts and lean production-system experts were completed. The participant list, training venue, venues for field visits, provisional agenda for the training, and related budget were prepared. Lean curriculum covering a 5-day lean management training program as well as potential topics for on-site workshops after the training were developed. Two webinars were conducted for the core group of the Lean Production team, and four webinars were conducted for groups of farmers/processors in Ogun State and Delta State.

Activity 1.4: Development of Bighead Catfish (*Clarias macrocephalus*) Culture for Sustainable Aquaculture in Cambodia

The team worked closely with key partners to provide two virtual trainings to Royal University of Agriculture faculty and students and the Cambodian activity team. The trainings built capacity in the local institution and focused on (1) formulating and preparing aquaculture feeds and (2) managing an aquatic research facility. In addition, the location of the wet lab was established, and the blueprint was developed and finalized. A list of materials and suppliers has been established.

Activity 1.5: Achieving Coral Reef Fishery Sustainability in the Kenyan Biodiversity and Climate Refugia Center

The activity was officially launched through small group meetings that reached 217 individuals across the activity sites. Socioeconomic, literacy testing, and fisheries survey tools were developed, translated into the Swahili language, piloted, and administered. The 15 top-ranking candidates were trained in data collection protocols and mobile phone data-collection procedures, and five community members and two county government fisheries officers were provided with mobile phone and internet bundles to be used for data collection. A community participatory fisheries resource mapping exercise was done in three sites, resulting in the production of hand-drawn and digitized maps of the identified fishing landmarks and fishing gear zones. An email-based stock-assessment training for individuals involved in marine research and management was done. It included fish identification training, where

the participants received a weekly image of a fish species along with information about the fish's key characteristics and English and Latin names.

Activity 1.6: Cryogenic Sperm Banking of Indian Major Carps (*Catla catla*, *Labeo rohita*, and *Cirrhinus cirrhosis*) and Exotic Carps (*Hypophthalmichthys molitrix*, *Hypophthalmichthys nobilis*, and *Ctenopharyngodon Idella*) for Commercial Seed Production and Brood Banking

Three MS and two PhD students were recruited. An activity inception workshop was conducted with 100 key stakeholder participants. The team prepared a memorandum of understanding (MOU) between Bangladesh Agricultural University and the Department of Fisheries for using the government hatchery and nursery facilities. The MOU will be signed soon. Along with historic stocks of Indian major carps (IMCs), three newly collected IMC stocks of Padma and Halda river origin are being reared in ponds with supplemental feeds for development of broodstock. In addition, another 50 of the three exotic carps (newly imported from China) received from the Department of Fisheries are being reared in ponds for brood development. A day-long training workshop for selected government and private hatchery operators and other stakeholders on cryopreservation of sperm and their use in breeding was conducted in four regions. Fin samples of brood fish were collected, and they are being genetically characterized using DNA microsatellite markers. Sperm from exotic carps, specifically silver carp, is being collected and cryopreserved.

Activity 1.7: Increasing Sustainability of Fisheries for Resilience of Cambodian Communities

The team successfully recruited two graduate students in Cambodia and established collaboration with two Cambodian professors from the Royal University of Agriculture, who will supervise the selected graduate students' research in collaboration with US PIs. The training of activity personnel in Cambodia is complete, as well as recruitment and training of 15 fishers from villages along the Sre Ambel River, who will participate in the citizen science initiative. The team made a fresh-fish processing video for digital workshops to be held in 2021. A Canvas course was created to be used as a training platform. This involved a variety of human-related research documents such as surveys, sensory questionnaires, and focus-group questionnaires—many of which were translated to Khmer.

Objective 2: Reduce and mitigate risks to aquaculture and fisheries

Activity 2.1: Improving Biosecurity: A Science-Based Approach to Manage Fish Disease Risks and Increase the Socioeconomic Contribution of the Nigerian Catfish and Tilapia Industries

Five online meetings were organized between teams and partners to discuss progress on activity milestones and planning. Enumerators and master's students were appointed at the University of Ibadan (UI). A WorldFish fish epidemiology and health economics survey-based tool was contextualized to Nigeria. Online teaching modules were developed by WorldFish on the learn.ink platform and completed by UI's activity manager, enumerators, and master's students. An online training workshop, organized by WorldFish, UI, and Mississippi State University PIs and co-PIs, was completed by enumerators and master's students. Census lists of farms and hatcheries located in Oyo and Delta States were finalized. Protocols for fish sampling diagnostics and plans to conduct field surveys and sample collection were developed.

Activity 2.2: Identifying the Major Sources of Fecal Pathogens in Bangladeshi Aquaculture Value Chains and Evaluating the Effectiveness of Various Risk Reduction Strategies

Fish collection from retail markets and lab testing activities were launched. Sampling from 11 retail markets and 12 super shops in Dhaka City was completed. A total of 134 samples were collected from retail markets and 47 from super shops. Fish samples were taken to the lab and tested for the presence of different foodborne pathogens. In parallel to sampling of fish, short interviews of fish vendors were conducted to know their behavioral practices associated with fish transportation, storage, and quality of water used to preserve live fish. All the needed materials were purchased so the team can perform diagnostic testing to detect food safety pathogens independently in the Ministry of Fisheries' laboratory.

Objective 3: Improve human outcomes from the aquaculture and fisheries sector

Activity 3.1: Harnessing Machine Learning to Estimate Aquaculture Production and Value Chain Performance in Bangladesh

Censuses of 3,554 aquaculture farming households in 36 villages and 1,319 traders in 50 markets were conducted, and survey sample frames were designed using the results. Individual respondent questionnaires for farms and traders and key-informant survey questionnaires of farming communities and markets were designed, field tested, digitized, and finalized. A one-week training for 12 data enumerators was conducted. Interviews with 721 farms, 228 fish traders, 36 farming communities, and 15 markets were completed, quality checked, and uploaded, and analysis of survey data began. Project staff was trained in using Google Earth Engine to create boundary polygons for delimiting waterbodies, and GPS coordinates were collected and used to create a database of boundary polygons using Google Earth Engine for 1,822 individual waterbodies. The coordinates and polygons were used to train a machine learning algorithm to detect and distinguish between aquaculture waterbody types. Two alternative models were developed, validated, and compared for waterbody detection (a logistic regression model and a decision tree model). A typology of aquaculture and nonaquaculture waterbodies was developed to further refine the decision tree model.

Activity 3.2: Nourishing Nations: Improving the Quality and Safety of Processed Fish Products in Nigeria

The activity was introduced to the Delta State Ministry of Agriculture and Natural Resources and the Agricultural Development Authority, and the team is working with both to identify women and youth fish processors for the baseline survey and training programs. A familiarization tour of Delta State was done to identify possible markets to conduct the market survey and collect fish samples. Development and design of several data collection tools were completed, including a pre- and postsurvey and quizzes to test information acquisition pre- and post-education. The team is developing a low-literacy nutrition education tool that will be used with participants in the training program, and it is being refined further through field testing. One PhD student and two MS students from the University of Calabar developed their research proposals.

Activity 3.3: FishFirst! Zambia: Research for Development and Scaling Staple-Fish Products for Enhanced Nutrition in the First 1,000 Days of Life

The team collaborated with WorldFish to develop and finalize the sampling design. Tablets were purchased to be used for fieldwork, and enumerators were identified for data collection. Graduate interns were selected to assist with data collection at Lake Kariba and create literature reviews on 1) postharvest losses and 2) fish consumption patterns and nutrition, which were completed and circulated for internal and external review. The team finalized the following survey instruments: Women's Empowerment in Fisheries Index+Postharvest Fish Loss Assessment-FishFirst! Zambia (WEFI-FFZ), Minimum Dietary Diversity-Women of Reproductive Age (MDD-WRA); and Minimum Dietary Diversity-Infants & Young Children (MDD-IYC; ages 6-23 months). The instruments were uploaded to KoBo Toolbox in preparation for fieldwork to pretest prior to data collection.

Activity 3.4: Samaki Salama: Securing Small-Scale Fisheries in Kenya for Healthy Nutrition and Ecosystems

The team completed the development of a household survey and other tracking tools that will measure the effects of the social marketing campaign; track the degree to which nutrition messaging is being received, understood, and used by mothers/caregivers and fishers over the course of the activity; and better understand gender norms and household decision-making power dynamics that may impact social marketing delivery. The team is currently reviewing and refining a job aid for home visits that will be utilized by the nutrition educator as well as in workshops and trainings targeted to fishers. The fisheries data-collection protocol is being finalized. The surveys and tools were approved by the Washington University in St. Louis Institutional Review Board and the Pwani University Ethics Committee in preparation for the start of baseline data collection.

Issues or concerns encountered during the reporting period

COVID-19 Pandemic-Related Issues

Second and third waves of COVID-19 in the US and host countries have caused delays in the implementation of activities, which has necessitated shifting activity timelines and adapting some subactivities to online mode. Travel restrictions made it impossible to hold several planned in-person

inception and activity roll-out meetings. Travel restrictions also prevented some teams from conducting in-person trainings, interviews, and surveys as well as other field activities. For example, the Cryogenic Sperm Banking activity in Bangladesh had difficulty visiting hatcheries, and Bangladesh Agricultural University has remained closed with most of the offices running with minimum manpower and limited working hours, which has caused delays in document processing. The Nourishing Nations team in Nigeria was affected by the COVID-19 pandemic programmatically and financially. Costs of goods and services have increased dramatically in Nigeria, which is experiencing high inflation rates; transportation costs have also increased.

COVID-19 Pandemic Mitigation Strategies

Due to travel restrictions caused by the COVID-19 pandemic, many of the activities developed strategies to mitigate and overcome this hurdle. The Biosecurity activity in Nigeria arranged for a meeting venue near the UI main campus that had a stable power supply with improved internet, audio, and video connectivity. This allowed participants in Nigeria to attend trainings face-to-face with safe social distancing with virtual attendance by PIs and co-PIs who were in other countries. The Cryogenic Sperm Banking activity in Bangladesh held an inception workshop in a large conference room, maintaining a safe physical distance between participants and using hand sanitizers and face masks, while also including a Zoom virtual platform for those who could not attend in person. The Lean Production System activity rented a facility in Nigeria to deliver training from the US because of travel limitations. The Nourishing Nations activity is planning to have a stakeholder’s meeting that will be in-person for the Nigerian team and virtual for the international collaborators. The Machine Learning activity in Bangladesh rented a private field office in Khulna close to the activity’s research areas/districts to facilitate training enumerators with social distancing and conducting surveys and interviews while minimizing the likelihood of COVID-19 transmission among the research team.

Alternative methods using online learning and platforms were developed as a replacement for face-to-face meetings, trainings, and other events due to COVID-19 restrictions. The Cryogenic Sperm Banking activity in Bangladesh displayed a video on sperm cryopreservation and fertilization of eggs using cryopreserved sperm to avoid personal contact. The Cambodian Fisheries and Food Processing activity developed video training and online courses and adapted a remote train-the-trainers approach.

Non-COVID-19 Pandemic-Related Issues

The Farm Diversification activity in Nigeria encountered a slowdown in activities related to seasonality; a peak in the dry season resulted in a lull in rice planting and fish-farming activities. The Coral Reef Fishery activity in Kenya got a slower-than-expected start because only a few individuals in the local communities had access to smartphones. Lack of electricity and the cost of mobile internet were additional contributing factors.

Human and Institutional Capacity Development, Other Cross-Cutting Themes, and Management Entity (ME)-Related Support

Short-Term Training

Country of Training	Brief Purpose of Training	Who was Trained	Number Trained		
			M	F	Total
Nigeria	Farm Diversification activity training of enumerators on socioeconomic questionnaires and management, graduate students for long-term training	People in Civil Society	23	12	35

Nigeria/Malaysia	Biosecurity activity training of enumerators in fish epidemiology and health economics survey tool	People in Civil Society	12	9	21
Bangladesh	Machine Learning activity training of enumerators in harnessing machine learning to estimate aquaculture production and value chain performance in Bangladesh	People in Civil Society	12	0	12
Bangladesh	Fecal Pathogens activity training on sampling, isolation, and identification of pathogenic microbes from fish and water samples	People in Government & USG-Assisted Private Sector Firms	8	1	9
Bangladesh	Cryogenic Sperm Banking activity training between host institutions on understanding of the underlying principles, theory, and practice of cryobiology, cryopreservation, and repository development	People in Government	6	0	6
Cambodia	Fisheries & Food Processing activity citizen science training workshop on data collection with the fishers	Producers	16	2	18
Kenya	Coral Reef Fishery activity trainings on fishery mapping, data-collection protocols of fisheries measurements, and fish group identification.	Producers, People in Civil Society, People in Government	55	25	80
Cambodia	Bighead Catfish activity trainings on formulating and preparing aqua feeds and managing a research facility	People in Civil Society	6	0	6
Total			138	49	187

Long-Term Training

PI and student number	Sex	University	Degree	Major	Program End Date	Degree Granted (Yes/ No)	Student's Home Country
Belton 1	M	Bangladesh Agricultural University	PhD	Aquaculture Systems and Development	2022/23	No	Bangladesh

Chadag 1	M	University of Ibadan	Master, Veterinary Public Health (MVPH)	Fish Epidemiology	2022/23	No	Nigeria
Chadag 2	F	University of Ibadan	Master, Veterinary Public Health (MVPH)	Fish Epidemiology	2022/23	No	Nigeria
Correa 1	M	Royal University of Agriculture	Master of Science (MS)	Center of Biodiversity Conservation Program	2023	No	Cambodia
Correa 2	F	Royal University of Agriculture	MS	TBD	2023	No	Cambodia
Halwart 1	M	University of Ibadan	PhD	Agriculture Economics	2023	No	Nigeria
Halwart 2	F	University of Ibadan	PhD	Fisheries Management	2023	No	Nigeria
Halwart 3	M	Usmanu Danfodiyo University, Sokoto	MS	Fisheries Ecology	2021	No	Nigeria
Halwart 4	F	University of Ibadan	MS	Fish Nutrition	2022	No	Nigeria
Halwart 5	F	University of Ibadan	MS	Fish Nutrition	2022	No	Nigeria
Halwart 6	F	University of Ibadan	MS	Fish Nutrition	2022	No	Nigeria
Halwart 7	M	Federal University of Technology Owerri	MS	Fish Nutrition	2021	No	Nigeria
Halwart 8	M	University of Ibadan	MS	Fish Nutrition	2022	No	Nigeria
Hok 1	M	Royal University of Agriculture	PhD	Agricultural Science	TBD	No	Cambodia

Iannotti 1	M	Pwani University	NA – postdoc	NA – postdoc	NA – postdoc	NA – postdoc	Kenya
Iannotti 2	F	University of Rhode Island	PhD	Environment and Life Sciences	TBD	No	USA
Iannotti 3	F	Washington University in St Louis	NA – postdoc	NA – postdoc	NA – postdoc	NA – postdoc	USA
Iannotti 4	F	Washington University in St Louis	Master of Public Health (MPH)	Global Health	August 2019	Yes	USA
Pincus 1	F	Mississippi State University	PhD	Food Science, Nutrition and Health Promotion – concentration Nutrition	2021	No	Nigeria
Pincus 2	F	University of Calabar	MS	Nutrition & Food Science	2022/23	No	Nigeria
Pincus 3	M	University of Calabar	MS	Nutrition & Food Science	2021/22	No	Nigeria
Ragsdale 1	M	University of Zambia	MS	Agricultural Economics	TBD	No	Zambia
Ragsdale 2	F	University of Zambia	MS	Human Nutrition	TBD	No	Zambia
Sarder 1	M	Bangladesh Agricultural University	PhD	Fish Breeding & Biotechnology	2024	No	Bangladesh
Sarder 2	M	Bangladesh Agricultural University	MS	Fish Breeding & Biotechnology	2021	No	Bangladesh
Sarder 3	M	Bangladesh Agricultural University	MS	Fish Breeding & Biotechnology	2021	No	Bangladesh

Other Cross-Cutting Theme Accomplishments

Gender Equity and Youth Engagement: Kathleen Ragsdale and Mary Read Wahidi, gender specialists, developed and administered the Gender-Responsive Aquaculture/Fisheries Development Assessment (GRADA-FIL) to all active Fish Innovation Lab grantees. The purpose of the GRADA-FIL is to help develop resources, trainings, tools, and communications to assist Fish Innovation Lab activities in advancing gender-responsive aquaculture and fisheries development. The GRADA-FIL is

also a learning tool that introduces Fish Innovation Lab partners to gender-responsive aquaculture and fisheries activities to further benefit their research and related capacity development activities. Lessons learned from applying the GRADA-FIL to the Quick Starts were published as a research brief. As the 13 Fish Innovation Lab activities are getting established, engaging graduate students, organizing enumerator trainings, connecting with producers etc., they are all keeping gender and youth in mind by preparing to collect gender- and youth-disaggregated data, ensuring gender balance in trainings, conducting gender- and youth-related assessments, and making a conscious effort to connect with female and youth engaged in the fish value chain. Two activities (Fish First! Zambia and Machine Learning in Bangladesh) are preparing to include the Women's Empowerment in Fisheries Index in their baseline surveys. The Fish Innovation Lab also participated in the Innovation Lab cross-cutting theme community of practice, which focuses on gender and capacity development.

Human Nutrition: Lora Iannotti, nutrition specialist, contacted PIs to assess interest levels and provide nutrition-related technical assistance. She provided resources and inputs to teams working in Cambodia, Bangladesh, Nigeria, and Zambia, helping the teams identify the most vulnerable nutritionally. Efforts were made to encourage targeting downstream access to fish foods for pregnant and lactating women, infants, and young children. Iannotti led the development of stories and blogs, including "More Bites of Fish Recommended in the Dietary Guidelines for Americans 2020-2025." She also worked with the USAID Advancing Nutrition team, which is not funded by the Fish Innovation Lab, to integrate their work with the Samaki Salama activity and plan some overarching social and behavior change materials for the Fish Innovation Lab activities. Some of the Fish Innovation Lab research activities spearheaded nutrition-related research and extension. For example, the Kenya Coral Reef Fishery activity gathered information via socioeconomic surveys that will assist in understanding the rate of household fish consumption. In addition, ongoing community data collection will help create awareness on the types and quantity of fish caught and landed in each site—information that will inform fisheries management decision making. The Nourishing Nations activity in Nigeria has developed an eight-module training to teach fish processors about nutrition, the nutritional benefits of fish consumption, food safety guidelines during fish processing, and sustainable practices in fish processing to improve their livelihoods and health. Finally, the FishFirst! Zambia activity finalized two nutrition-related survey instruments: the Minimum Dietary Diversity-Women of Reproductive Age (MDD-WRA) and the Minimum Dietary Diversity-Infants and Young Children (MDD-IYC; ages 6-23 months), both modified for Tonga and Nyanja speakers.

Resilience of Value Chains/Households: Joanna Springer, resilience specialist, published a blog on building resilience of fisheries and aquaculture systems. The blog was selected for the Agrilinks newsletter in December 2020. The RTI team developed a resilience cross-cutting theme scope, detailing out how the resilience advisor will support the Fish Innovation Lab to provide awareness and training to subawardees on resilience as well as to conduct more focused resilience within some of the activities.

Capacity Building: Glenn Ricci, capacity development specialist, conducted a survey for all students in Fish Innovation Lab activities to gauge their interest in developing a Fish Innovation Lab student community of practice. Fish Innovation Lab activities have engaged many graduate students, and one PhD student in the Nourishing Nations activity in Nigeria defended her dissertation proposal in April 2021. All of the Fish Innovation Lab research-for-development activities were reviewed to identify where technical assistance will be needed. Capacity development and stakeholder engagement was the topic for the Asia Learning Agenda Session in February 2021. Multiple research teams developed training curricula and conducted trainings. For example, in Bangladesh, the Machine Learning activity trained data enumerators; the Cryogenic Sperm Banking activity trained eight public- and 14 private-sector hatchery operators in cryogenic banking technologies; and the Fecal Pathogens activity trained individuals from eight government and private institutions. Finally, activities are engaging communities directly in citizen science. For example, in the Cambodia Fisheries and Food Processing activity, 14 community members were selected to participate in citizen science activities; and in the Kenya Coral Reef Fishery activity, 17 community members were trained in data collection protocols and mobile phone data-collection procedures related to fisheries stock assessment and coral reef ecology. Five community members and two fisheries officers began fish-landing monitoring in early 2021.

Management Entity (ME) and Partner Activities

The Fish Innovation Lab ME implements its research portfolio to achieve knowledge and technology adoption, scaling, and impact. An important activity completed in the first half of Year 3 was supporting the 13 research-for-development activities as they conducted their first year of research and capacity development. The ME also supported the teams as they adapted to circumstances caused by the COVID-19 pandemic; implemented the learning agenda and research strategy; finalized the selection of commissioned activities; and communicated results, lessons learned, and success stories related to Fish Innovation Lab-supported activities. Indicator results were collected, and they are presented in Appendix 2.

Future Work

The next steps for the activities in implementing their work plans are as follows:

Research Activities
See Appendix 3

Management Entity Activities
<ul style="list-style-type: none">● Support research-for-development activities in the development of methods and technologies as well as implementing cross-cutting themes● Finalize and launch commissioned activities● Conduct monthly and quarterly PI and ME partner meetings and platform learning sessions● Conduct virtual annual PI meeting● Conduct virtual learning; monitoring, evaluation, and learning (MEL); communications; and finance/administration trainings for new commissioned activity subawardees● Facilitate and manage the virtual workspaces for internal communication and teambuilding● Develop and distribute quarterly newsletter● Track and contribute to USAID-led learning and sharing opportunities as requested, including the Innovation Lab cross-cutting theme community of practice● Support human and institutional development activities to subawardees● Implement research activity MEL, including collecting quarterly research activity results (narrative reporting inputs and indicator results)● Implement learning agenda and research strategy

Appendix 1. Semi-Annual Progress Summary Table

Objectives, Activities and Sub-Activities	Country of Activity	Person or Institution Responsible	FY2021 Progress
Objective 1: Improve aquaculture and fisheries productivity			
Activity 1.1: Aquaculture and rural communities: Farm diversification strategy through integrated agriculture-aquaculture systems and nutrition-sensitive value chains for better nutrition outcomes in Nigeria			
1.1.1: Development of suitable integrated rice-fish production technology through participatory research actions	Nigeria	Halwart Lead PI (FAO), Xinhua Lead Co-PI (FAO), Fonsah US PI (UGA), Burtle US Co-PI (UGA), Ajani HC PI (UI), Omitoyin HC Co-PI (UI)	The team established six adaptive research plots (three in Ebonyi and three in Kebbi) that are near 90% completion and ready for stocking with fish and rice planting. Using GPS, ten wetland maps of the study areas were produced (including the flooding regimes, land use pattern, and vegetation patterns). The report of the preliminary rural community appraisals for the six activity sites in the two states was produced and finalized.
1.1.2: Understanding convenient market access approach and nutrition contributions of rice-fish farming products			Data on situational analyses of nutrition status, gender, and youth involvement before the intervention process was collected. Baseline information from quantitative and qualitative data on households through a food security survey, fish consumption survey, and utilization of rice-field aquatic resources by rice-fish farmer households and other households in the community were collected. These data are being analyzed by the FAO team for the final presentation. About 200 respondents were administered the questionnaires. Socioeconomic questionnaires to be administered to the target groups and stakeholders were developed, and 20 enumerators were trained on questionnaire administration.
1.1.3: Capacity development and enhancement of co-learning			The activity completed the engagement of two PhD students and six MS students. Thesis and project proposals are being examined/developed, and working titles are ongoing and nearing completion.
Activity 1.2: No longer bugged by feed costs: Farming insects as sustainable and scalable aquaculture feedstock to improve catfish (<i>Clariidae</i>) producers' and consumers' livelihoods towards food security in Nigeria			
1.2.1: Co-optimize integrated insect-to-fish (ITF) farming system infrastructure to increase local production of fish while minimizing costs of production	Nigeria	Pechal Lead and US PI (MichSU), Valle de Souza US Co-PI (MichSU),	The team contacted the program managers of the Ebonyi and Cross River Agricultural Development Programs about how fish farmers are organized in the two Nigerian states where the activity is implemented. The team connected with fisheries subject-matter specialists in the two states.

<p>1.2.4: Define and model the relationships among stages of production throughout the ITF farming system and construct a relational map of optimal profitability points for black soldier fly and catfish production</p>		<p>Omonona HC PI (UI)</p>	<p>The pilot fish-farmer survey was developed (it is a survey of over 700 potential questions for participants), with expected pilot survey implementation and subsequent survey instrument revision in the next six weeks. This survey/questionnaire is being programmed into KoBo Toolbox, which can work with android-based tablets for computer-aided personal interviews of participants in the study sites. Full survey implementation will occur by the end of the calendar year.</p>
<p>Activity 1.3: Improving efficiency in the Nigerian aquaculture sector by employing lean production systems</p>			
<p>1.3.1: Improve operational efficiency, reduce postharvest losses, improve waste management, and decrease the cost of production of catfish and tilapia in Nigerian aquaculture through application of Lean Production Systems</p>	<p>Nigeria</p>	<p>Subasinghe Lead and HC PI (WorldFish), Siriwardena HC Co-PI (WorldFish), Nukpezah US PI (MSU), Steensma US Co-PI (WUSTL)</p>	<p>Planning and preparation for the lean subject-matter experts and lean production-system experts was completed. The team organized the participant list, training venue, venues for field visits, related budget, and prepared a provisional agenda for the training. A lean curriculum covering a 5-day lean management training program was developed, including potential topics for on-site post-training workshops. Two webinars were conducted for the core group of the Applying Lean Management in Aquaculture Production activity. The webinars introduced lean history, vocabulary, and principles to the core team and discussed basic lean tools and their application in aquaculture value chain, project types, and data collection and management. Four webinars were conducted for groups of farmers/processors in Ogun State and Delta State. The trainings delivered materials on introducing lean history, vocabulary, and principles; educated on some of the basic lean tools and their application in aquaculture; and discussed how to identify lean mini-projects and associated measurements. The trainings included a post-training fieldwork assignment to identify specific problem areas to apply lean management tools and knowledge.</p>
<p>Activity 1.4: Development of bighead catfish (<i>Clarias macrocephalus</i>) culture for sustainable aquaculture in Cambodia</p>			
<p>1.4.1: Strengthening the institutional and human aquaculture-research capacity of local institutions in Cambodia, especially RUA</p>	<p>Cambodia</p>	<p>Hok Lead and HC PI (CESAIN RUA), Yossa HC Co-PI (WorldFish), Reyes US PI (KSU), Gatlin</p>	<p>The activity team worked closely with key partners to provide two virtual trainings to RUA faculty and students and the Cambodian activity team. The training focused on (1) formulating and preparing aquaculture feeds and (2) managing an aquatic research facility to build the capacity of the local institution (RUA). There were nine participants (all males) for each training including activity staff, faculty members, and six students (youth).</p>

<p>1.4.2: Development and scaling of cost-effective formulated feeds for the sustainable culture of local bighead catfish (<i>Clarias macrocephalus</i>) in Cambodia</p>		<p>US Co-PI (TAMU)</p>	<p>The team coordinated regularly scheduled meetings between the activity team, the faculty of fisheries of RUA, the WorldFish team, and KSU to discuss, plan, share challenges, propose solutions, update progress of activities, and set up plans for the next activity implementation, particularly to facilitate the process of wet-lab installation. The team reached some achievements directed at this objective such as selecting the location, developing and finalizing the blueprint of the wet lab, finalizing the list of materials, and identifying the suppliers of those materials.</p>
<p>Activity 1.5: Achieving coral reef fishery sustainability in the Kenyan biodiversity and climate refugia center</p>			
<p>1.5.1: Determine the yield potential for coral reef climate refugia to support improved fisheries management</p>	<p>Kenya</p>	<p>McClanahan Lead and US PI (WCS), Muthiga US Co-PI (WCS), Humphries US Co-PI (URI), Mbaru HC PI (KMFRI)</p>	<p>The activity was officially launched in all sites by holding small group meetings; objectives and anticipated results were communicated to 217 stakeholders that participated across all sites. Communicating the activity status with individuals made them aware of the implementation process. Community members embraced and agreed to participate in the project activities.</p>
<p>1.5.2: Determine the best metrics for measuring sustainability to enhance the likelihood of sustainable management</p>			<p>Socioeconomic and fisheries survey tools were developed, translated into the Swahili language for easy understanding by the local communities, piloted, and administered to 193 households. Literacy testing of 110 volunteer members of the communities in all activity sites was conducted. For the socioeconomic surveys, a total of 74 questionnaires were completed in Mkwiro, Wasini, and Kibuyuni communities. The survey enabled the team to identify 17 individuals that were trained on data collection protocols and mobile phone data-collection procedures from all the sites. A total of five community members and two county government fisheries officers were provided with mobile phones and internet bundles to be used in the fish-landings monitoring activity, communication, and information sharing. Community participatory fisheries resource mapping was done in three sites, bringing together a total of 73 fisheries stakeholders (those using different gears, boat operators, seaweed farmers, beach management units, community leaders, county-government fisheries officers, and Kenya Wildlife Service officers). The activity resulted in the production of both hand-drawn and digitized maps of the identified fishing landmarks and fishing gear zones.</p>
<p>1.5.3: Improve the management capacity of communities to monitor fisheries and habitats and use this information for adaptive management</p>			<p>A virtual stock-assessment training on fish identifications was initiated, which included weekly emails with a species image and information on its characteristics and English and Latin names.</p>
<p>Activity 1.6: Cryogenic sperm banking of Indian major carps (<i>Catla catla</i>, <i>Labeo rohita</i>, and <i>Cirrhinus cirrhosus</i>) and exotic carps (<i>Hypophthalmichthys molitrix</i>, <i>Hypophthalmichthys nobilis</i>, and <i>Ctenopharyngodon Idella</i>) for commercial seed production and brood banking in Bangladesh</p>			

<p>1.6.1: Develop donor broodstocks of Indian major carps (IMCs) and three exotic carps</p>	<p>Bangladesh</p>	<p>Sarder Lead and HC PI (BAU), Rahman HC Co-PI (BAU), Tiersch US PI (LSU)</p>	<p>Overall accomplishments include the recruitment of three MS and two PhD students. The inception workshop of the activity was conducted with around 100 participants including the US PI, Asia Country Coordinator, university officials, and other key stakeholders. An MOU between BAU and the Bangladesh Department of Fisheries for using the government hatchery and nursery facilities was prepared and will be signed soon. Along with historic stocks of IMCs, three newly collected IMCs of Padma and Halda river-origin are being reared in ponds with supplemental feeds for development of broodstock. In addition, another 50 of the three exotic carps (newly imported from China) were received from DoF, and they are being reared in ponds for brood development.</p>
<p>1.6.2: Cryopreserve sperm of IMCs and exotic carps and develop a cryogenic sperm bank</p>			<p>A day-long training workshop for selected government, private hatchery operators, and other stakeholders on cryopreservation of sperm and its use in breeding was conducted in four regions. Genetic characterization of brood fish and cryopreservation of sperm for cryogenic sperm banking are being conducted. Fin samples of brood fish were collected, and their genetic characterization using DNA microsatellite markers is being conducted. Sperm from exotic carps, specifically silver carp, is being collected and cryopreserved.</p>
<p>1.6.3: Produce seeds of carps in hatcheries using cryopreserved sperm and characterize and assess their quality through growth study and DNA microsatellite analysis</p>			<p>Forty-six government and private hatcheries located in Mymensingh, Jashore, Faridpur, and Barishal regions were visited and selected for research work. During the visits, the team discussed the specifics of the research program with hatchery operators. A series of six interactive virtual training workshops were organized by the LSU AgCenter on different aspects of cryopreservation of fish sperm and development of a repository; it was attended by BAU activity participants.</p>
<p>Activity 1.7: Increasing sustainability of fisheries for resilience of Cambodian communities</p>			
<p>1.7.1: Improve sustainable fisheries management by assessing changes in the existing fishery through the development of a protocol to monitor fish populations and implementation of a citizen science digital platform for documentation and analysis of harvest</p>	<p>Cambodia</p>	<p>Correa Lead and US PI (MSU), Neal US Co-PI (MSU), Allen US Co-PI (MSU), Dinh US Co-PI (MSU), Schilling US</p>	<p>The team successfully recruited two graduate students in Cambodia and established collaboration with two Cambodian professors (Center of Biodiversity Conservation and Development Studies) from RUA. One professor from each master's program will supervise the selected graduate students on their research in collaboration with US PIs. The training of activity personnel in Cambodia is complete, as well as recruitment and training of 15 fishers from villages along the Sre Ambel River to participate in the citizen science initiative. Although there was a delay, fishers have begun collecting harvest data.</p>

<p>1.7.2: Educate and train in food processing and preservation techniques to reduce fish waste and enhance food security</p>		<p>Co-PI (MSU), Sitha HC PI (WCS), Mahood HC Co-PI (WCS)</p>	<p>The team made a fresh-fish processing video for digital workshops to be held in 2021. A Canvas course was created and is waiting for approval to be used as a training platform. All the human-related research documents such as surveys, sensory questionnaires, and focus-group questionnaires were completed. A survey instrument and consent forms for community surveys were completed, translated to Khmer, and printed for future surveys. In addition, the team also completed a focus-group questionnaire and video and audio consent forms, which have been translated to Khmer and submitted to the MSU Office of Research Compliance.</p>
<p>Objective 2: Reduce and mitigate risks to aquaculture and fisheries</p>			
<p>Activity 2.1: Improving biosecurity: A science-based approach to manage fish disease risks and increase the socioeconomic contribution of the Nigerian catfish and tilapia industries</p>			
<p>2.1.1: To understand epidemiology and health economics of catfish and tilapia aquaculture in Ogun and Delta states, Nigeria</p>	<p>Nigeria</p>	<p>Chadag Lead PI (MSU), Subasinghe Lead Co-PI (WorldFish), Hanson US PI (MSU), Wills US Co-PI (MSU), Adeyemo HC PI (UI), Aina HC Co-PI (UI)</p>	<p>Five online meetings were organized between teams and partners to discuss progress on activity milestones and planning. Enumerators and master's students were appointed at UI. Three teaching modules were developed by WorldFish on the learn.ink platform and completed by UI's project manager, enumerators, and master's students. Enumerators, master's students, and other UI staff attended a 3-day virtual training workshop organized by WorldFish, UI, and MSU PIs and Co-PIs. A WorldFish fish epidemiology and health economics survey-based tool was contextualized to Nigeria after taking input from the Nigeria team.</p>
<p>2.1.2: To understand health status of catfish and tilapia in a regional model by employing presumptive field and laboratory diagnostics</p>		<p>Census lists of farms and hatcheries located in Oyo and Delta States were finalized. Protocols for fish sampling diagnostics were developed. Plans to conduct field surveys and sample collection were developed.</p>	
<p>Activity 2.2: Identifying major sources of fecal pathogens in Bangladeshi aquaculture value chains and evaluating the effectiveness of various risk reduction strategies</p>			
<p>2.2.1: Determine the prevalence of foodborne pathogens in pangas and tilapia fish at point-of-delivery to consumers at retail fish markets in Dhaka City</p>	<p>Bangladesh</p>	<p>Islam Lead and US PI (WSU), Narrad US Co-PI (UMD), Amin HC PI (icddr,b)</p>	<p>Fish collection activities from retail markets and their lab testing activities were launched. Sampling from 11 retail wet-markets and 12 super shops in Dhaka City was completed; a total of 181 samples were collected (134 from retail markets and 47 from super shops). Fish samples were taken to the lab and tested for the presence of different foodborne pathogens (<i>Vibrio</i>, <i>Shigella</i>, <i>Salmonella</i>, toxigenic <i>E. coli</i>, and <i>Cryptosporidium</i>). Isolation and identification of the target pathogens was completed.</p>

<p>2.2.2: Identify pre-market and at-market practices and conditions associated with increased microbial contamination on fish at sale and key points, actors, and stakeholders for intervention within the value chain</p>			<p>In parallel to sampling of fish in the markets for subsequent lab analysis, short interviews of fish vendors were conducted to understand their behavioral practices associated with fish transportation, storage, and quality of water used to preserve live fish. A questionnaire-based survey of vendors in the wet market ($n = 134$) and super shops ($n = 12$) was completed. All the laboratory supplies needed for detection of foodborne pathogens in the Ministries of Fisheries laboratories, a subaward organization, were purchased to enable them to perform food safety pathogens detection independently in their own laboratory. The lab supplies were repackaged and are ready for dispatching.</p>
<p>Objective 3: Improve human outcomes from the fisheries sector</p>			
<p>Activity 3.1: Harnessing machine learning to estimate aquaculture production and value chain performance in Bangladesh</p>			
<p>3.1.1: Disseminate knowledge via novel pathways to facilitate widespread utilization resulting in positive behavior change and technology adoption</p>	<p>Bangladesh</p>	<p>Belton Lead and US PI (MichSU), Nejadhashemi US Co-PI (MichSU), Haque HC PI (BAU), Murshed-e-Jahan HC Co-PI (BAU)</p>	<p>(1) A census of 3,554 aquaculture farming households in 36 villages and 1,319 traders in 50 markets was conducted, and survey sample frames were designed using the results. (2) Individual respondent questionnaires for farms and traders and key-informant survey questionnaires of farming communities and markets were designed, field tested, digitized, and finalized. A questionnaire for input providers was designed. (3) A one-week training for 12 data enumerators was conducted in December. (4) Interviews with 721 farms (against 720 listed in proposal), 228 fish traders (against 230 listed in proposal), 36 farming communities, and 15 markets were completed, quality checked, and uploaded. (5) Reshaping and cleaning of farm survey datasets was begun. (6) Analysis of farming-community survey data was begun.</p>
<p>3.1.2: Generate knowledge on improved technologies and practices and on the contributions of Bangladesh's aquaculture sector to nutrition, women's and youth participation, and access to economic resources</p>			<p>(7) Activity staff were trained in using Google Earth Engine to create boundary polygons for delimiting waterbodies. (8) GPS coordinates were collected, and a database of boundary polygons using Google Earth Engine was created for 1,822 individual waterbodies. (9) The collected GPS coordinates and polygons were used to train a machine learning algorithm to detect and distinguish between aquaculture waterbody types. (10) Two alternative models for waterbody detection were developed, validated, and compared (a logistic regression model and a decision tree model). (11) A typology of aquaculture and non-aquaculture waterbodies was developed to further refine the decision tree model.</p>
<p>Activity 3.2: Nourishing nations: Improving the quality and safety of processed fish products in Nigeria</p>			

<p>3.2.1: Develop cost-per-nutrient guides by analyzing the nutrient and contaminant profile of select processed fish products and their respective prices in comparison to other animal-source foods available in the Delta State of Nigeria</p>	<p>Nigeria</p>	<p>Pincus Lead PI (WorldFish), Tolar-Peterson US PI (MSU), Ene-Obong HC Co-PI (UNICAL)</p>	<p>The activity was introduced to the Delta State Ministry of Agriculture and Natural Resources (MANR) and the Agricultural Development Authority (ADP). The team is working with the project director and the project manager at the ADP as well as the director of planning, research, and statistics in the MANR to identify women and youth fish processors for the baseline survey and training programs. The UNICAL team also conducted a familiarization tour of Delta State to identify possible markets to conduct the market survey and collect fish samples. The development and design of several data collection tools was completed, including a pre- and post-survey (in Qualtrics) and eight pre- and post-quizzes to test information acquisition pre- and post-education. The team has started to develop a low-literacy nutrition education tool that will be used with participants in the training program. The tool will be refined further through field testing. In addition, MSU has been refining nutrition information specific to fish that can be used in the training program.</p>
<p>3.2.2: Build capacity among women and youth fish processors in the Delta State to produce high-quality, safe and nutritious processed fish products for local consumption</p>			<p>Student involvement included one PhD student-developed dissertation proposal. Grace Adegoye (Nigerian nationality) completed her dissertation research proposal, which is based on baseline data collection from this activity. In addition, two MS students from UNICAL developed their research proposals; one student will be studying contaminants and food safety of the processed fish products available in the markets, and the other student will be studying nutrition and the cost per nutrient of fish products in relation to other animal-source foods.</p>
<p>Activity 3.3: FishFirst! Zambia: Research for development and scaling staple-fish products for enhanced nutrition in the first 1,000 days of life</p>			
<p>3.3.1: Assess current state of small pelagic fish harvesting, processing, and trading activities from point of catch through processing to local and distant markets for sale in rural and urban areas</p>	<p>Zambia</p>	<p>Ragsdale Lead and US PI (MSU), Read-Wahidi US Co-PI (MSU), Mudege HC PI (WorldFish), Marinda HC Co-PI (UNZA)</p>	<p>The protocol for ethical approval was submitted to the WorldFish Protocol Review Committee, and permission was granted to submit the protocol to the UNZA Ethics Review Committee. Subsequently, protocol documentation was prepared for submission to the UNZA Ethics Review Committee. The team collaborated with WorldFish to develop and finalize the sampling design. Tablets were purchased for fieldwork, and 14 enumerators were identified for data collection. Graduate interns were selected to assist with data collection at Lake Kariba and conduct literature reviews. The two literature-review protocols were on 1) postharvest losses and 2) fish-consumption patterns and nutrition; they were circulated for internal and external review.</p>
<p>3.3.2: Identify social and gender barriers to entry and/or participation in these value chain activities for the different actors, particularly women and youth</p>			<p>The team finalized survey instruments: Women's Empowerment in Fisheries Index + Postharvest Fish Loss Assessment-FishFirst! Zambia (WEFI-FFZ), Minimum Dietary Diversity-Women of Reproductive Age (MDD-WRA; modified for Tonga and Nyanja speakers), and Minimum Dietary Diversity-Infants & Young Children (MDD-IYC; ages 6-23 months; modified for Tonga and Nyanja speakers). The instruments were uploaded to KoBoToolbox in preparation for fieldwork to pretest prior to data collection. Weekly meetings to monitor work progress and collaborate on the development of the survey instruments were implemented.</p>
<p>Activity 3.4: Samaki Salama: Securing small-scale fisheries in Kenya for healthy nutrition and ecosystems</p>			

3.4.1: Nutrition social marketing (Determine the effects of a multi-tiered social marketing campaign to promote fish nutrition, dietary diversity, and food safety on child growth)	Kenya	Iannotti Lead and US PI (WUSTL), Humphries US Co-PI (URI), Wamukota HC PI (PU), Kamau-Mbuthia HC Co-PI (EU)	The team completed development of the household survey and other tracking tools that will measure the effects of the social marketing campaign; track the degree to which nutrition messaging is being received, understood, and used by mothers/caregivers and fishers over the course of the activity; and better understand gender norms and household decision-making power dynamics that may impact social marketing delivery. Collaboration with USAID Advancing Nutrition, as well as formative information collected from the field, furthered the development of the household survey and tracking tools, and the messaging and delivery platform were refined. This collaboration was particularly informative for drafting messaging targeted at fishers. The team is currently reviewing and refining a job aid for home visits that will be utilized by the nutrition educator and for workshops and trainings that will target fishers. The research team continues to explore options for fisher intervention in the design of cooperatives, taking into consideration information from the receptivity survey and sample size needs.
3.4.2 Fisher cooperatives (Measure the impact of fishing-gear cooperatives on gear modification and diversification, as well as catch dynamics and earnings)	Kenya	Humphries US co-PI (URI), Wamukota HC PI (PU)	The fisheries data-collection protocol is being finalized. The surveys and tools were approved by the WUSTL Institutional Review Board and PU Ethics Committee in preparation for the start of baseline data collection.
Objective 4: Effectively manage a portfolio of research-for-development activities in aquaculture and fisheries and implement a knowledge management plan			
Activity 4.1: Support the competitively awarded Fish Innovation Lab research-for-development activities	United States, Bangladesh, Kenya, Nigeria, Zambia, Cambodia	Lawrence (MSU), Torell (URI), Allen (MSU), Dees (MSU), Dey (TSU), Hill (MSU), Humphries (URI), Hussain (BAC), Iannotti (WUSTL), Jeudin (RTI),	Research activities were supported via quarterly PI and learning meetings and one-on-one meetings. GRADA-FIL was applied to assess gender needs. Individualized capacity development and nutrition-related technical assistance are under development. Country and regional coordinators provided ongoing support to their respective teams. The ME participated in the Innovation Lab cross-cutting theme community of practice.
Activity 4.2: Commission complementary research studies			Six commissioned studies were identified, and all the information needed for submitting subaward approval requests to USAID was gathered.
Activity 4.3: Implement knowledge management plan			Online training was developed on communications, MEL, and subaward management. Commissioned activity PIs attended the training. Blogs, technical briefs, and other media highlighting Fish Innovation Lab activities and the ME partners' work were developed and disseminated. A quarterly newsletter was developed and distributed. A document highlighting outcomes and lessons learned from the Quick Start activities was developed.

<p>Activity 4.4: Monitoring, evaluating, and learning from research findings, determining factors that limit adoption of new knowledge/technologies, and scaling</p>		<p>Kent (URI), Ragsdale (MSU), Ricci (URI), Reichley (MSU), Siriwardena (WorldFish), Springer (RTI), Wamukota (PU), Zselezky (MSU)</p>	<p>A learning agenda and research strategy were developed and refined with input from PIs and ME partners. Semi-annual virtual platform meetings were conducted on topics specified in the learning agenda. FIL research activities were monitored, and quarterly and semi-annual indicator data were collected.</p>
---	--	--	--

FAO, United Nations Food and Agriculture Organization; UGA, University of Georgia; UI, University of Ibadan; MichSU, Michigan State University; MSU, Mississippi State University; CESAIN RUA, Center of Excellence on Sustainable Agricultural Intensification at Royal University of Agriculture; KSU, Kansas State University; TAMU, Texas A&M University; WCS, Wildlife Conservation Society; URI, University of Rhode Island; KMFRI, Kenya Marine and Fisheries Research Institute; BAU, Bangladesh Agricultural University; LSU, Louisiana State University; WSU, Washington State University; UMD, University of Maryland; icddr,b, International Center for Diarrheal Disease Research, Bangladesh; UNICAL, University of Calabar; UNZA, University of Zambia; WUSTL, Washington University in St. Louis; PU, Pwani University; EU, Egerton University; TSU, Texas State University; BAC, Blue Aquaculture Consulting; RTI, Research Triangle Institute

Appendix 2. Semi-Annual Indicator Results Table

In Quarters 1 and 2 of FY21 the project achieved the following:

- **EG.3.2-1: Number of individuals who have received USG-supported short-term agricultural sector productivity or food security training.** The project reached 187 beneficiaries, including 138 men and 49 women.
- **EG.3-2: Number of individuals participating in USG food security programs.** The overall project reached 462 beneficiaries, including 337 men and 125 women.
- **EG.3.2-7: Number of technologies or management practices under research, under field testing, or made available for transfer as a result of USG assistance.** The project has six technologies in the research process.
- **EG.3.2-24: Number of individuals in the agriculture system who have applied improved management practices or technologies with USG assistance.** The project reached 32 beneficiaries, including 26 men and 6 women, who applied improved practices and technologies.

EG.3.2-1: Number of individuals who have received USG-supported short-term agricultural sector productivity or food security training					
Disaggregations	LOP* to Date	FY2019	FY2020	FY 2021 (Q1-Q2)	
	Actual	Actual	Actual	Target	Actual
Gender					
Male	138	0	0	0	138
Female	49	0	0	0	49
Totals	187	0	0	0	187
Participant Type					
People in Government	16	0	0	0	16
USG-Assisted Private Sector Firms	4	0	0	0	4
People in Civil Society	82	0	0	0	82
Producers	85	0	0	0	85
Totals	187	0	0	0	187

EG.3-2: Number of individuals participating in USG food security programs

Disaggregations	LOP* to Date	FY2019	FY2020	FY 2021 (Q1-Q2)	
	Actual	Actual	Actual	Target	Actual
Gender					
Male	478	28	113	497	337
Female	399	222	52	257	125
Totals	877	250	165	754	462
Age					
15-29	264	132	33	236	99
30+	426	118	132	518	176
Unknown					179
Totals	690	250	165	754	454
Participant Type					
People in Government	71	Unknown	Unknown	20	71
USG-Assisted Private Sector Firms	22	Unknown	Unknown	22	22
People in Civil Society	115	Unknown	Unknown	57	115
Laborers	27	Unknown	Unknown	20	27
Producers	189	Unknown	Unknown	597	189
Totals	424	0	0	716	424

EG.3.2-7: Number of technologies or management practices under research, under field testing, or made available for transfer as a result of USG assistance

Disaggregations	LOP* to Date	FY2019	FY2020	FY 2021 (Q1-Q2)	
	Actual	Actual	Actual	Target	Actual
Status					
Phase 1: Under Research	5	0	2	1	3
Phase 2: Under Field Testing	2	0	0	0	2
Phase 3: Made Available for Transfer	1	0	0	0	1
Phase 4: Demonstrated Uptake by the Public and/or Private Sector	1	0	1	0	0
Totals	9	0	3	1	6
Research type					
Plant and Animal Improvement Research	3	3	3	1	3
Production Systems Research	2	0	0	0	2
Social Science Research	1	0	0	0	1
Totals	6	3	3	1	6

EG.3.2-24: Number of Individuals in the agriculture system who have applied improved management practices or technologies with USG assistance

Disaggregations	LOP* to Date	FY2019	FY2020	FY 2021 (Q1-Q2)	
	Actual	Actual	Actual	Target	Actual
Gender					
Male	42	13	3	236	26
Female	23	10	7	40	6

Totals	65	23	10	276	32
Age					
15-29	20	11	6	51	3
30+	38	12	4	225	22
Totals	58	23	10	276	25
Participant Type					
Parents/Caregivers	0	Unknown	Unknown	0	0
People in Government	2	Unknown	Unknown	9	2
USG-Assisted Private Sector Firms	0	Unknown	Unknown	42	0
People in Civil Society	0	Unknown	Unknown	11	0
Producers	30	Unknown	Unknown	214	30
Totals	32	Unknown	Unknown	276	32

*LOP, life of program

Appendix 3. Future Work for Research Activities

Activity	Sub-Activities planned for April 1 to September 30, 2021
Halwart: Farm Diversification (Nigeria)	<ol style="list-style-type: none"> 1. Establish cluster rice field farms (6 in total; 3 per state) 2. Conduct preliminary analysis of parameters for integrated rice-fish farming system 3. Conduct mid-activity assessment to determine profitability margins or return on investment, growers' acceptability, and consumer purchasing behavior and willingness to pay 4. Study the suitability of locally available feedstuffs 5. Enhance the effectiveness of integrated agriculture-aquaculture innovation platform
Chadag: Biosecurity (Nigeria)	<ol style="list-style-type: none"> 1. Conduct and analyze survey questionnaires with up to 320 tilapia and catfish farmers and up to 30 tilapia and catfish hatchery owners across Ogun and Delta states 2. Collect biological samples from a total of 15 farm sites (intensive and river-based) per species and up to three to five hatcheries for each species 3. Develop new teaching modules on fish sampling techniques for laboratory diagnostics developed on the learn.ink platform 4. Develop biosecurity checklist for farmers and hatchery operators in Ogun and Delta States 5. Develop tilapia and catfish clinical sign posters
Belton: Machine Learning (Bangladesh)	<ol style="list-style-type: none"> 1. Complete the remaining interviews with fish traders and key-informant interviews at markets, and conduct input supplier survey 2. Conduct virtual data-analytics capacity building workshop for activity team 3. Clean and analyze the farm, trader, and farming community datasets, and produce initial descriptive statistics 4. Refine and finalize algorithm for identifying waterbodies used for aquaculture 5. Map and summarize data extracted from remotely sensed satellite images 6. Conduct virtual stakeholder consultation workshop on features for inclusion in the geographic information system (GIS) interface
Islam: Fecal Pathogens (Bangladesh)	<ol style="list-style-type: none"> 1. Finalize the collection of 500 cut-fish samples from 20 retail markets and 25 super shops 2. Enroll at least two MS students 3. Conduct focus-group discussions and structured observation of different stakeholders 4. Organize virtual stakeholder meetings
Pechal: Farming Insects (Nigeria)	<ol style="list-style-type: none"> 1. Conduct reconnaissance survey to list fish farmers in the study location 2. Conduct baseline survey 3. Conduct preliminary modeling of fish farms' production systems 4. Begin the intervention by setting up the demonstration plots for black soldier fly larvae production, processing, and mixing this with feed ingredients for making fish feed

Iannotti: Samaki Salama (Kenya)	<ol style="list-style-type: none"> 1. Recruit fishers with children under the age of 5 2. Refine and pilot data collection tools and social marketing materials 3. Collect baseline data from intervention and control households
Sarder: Cryogenic Sperm Banking (Bangladesh)	<ol style="list-style-type: none"> 1. Collect additional Indian major carps and exotic carps for broodstock development 2. Characterize the genetics of broodstocks 3. Conduct breeding trials using cryopreserved sperm in selected hatcheries in four regions 4. Sign memorandum of understanding (MOU) with the Bangladesh Department of Fisheries 5. Recruit PhD and MS students
Correa: Fisheries & Food Processing (Cambodia)	<ol style="list-style-type: none"> 1. Conduct training and field checks on adjusted data collection protocols with 14 contracted fishers to ensure that data is recorded correctly 2. Conduct training for Wildlife Conservation Society staff about data management, data entry, and data storage. 3. Enter weekly fisheries data into the computer and identify first fish species (done by ichthyologist) 4. Design and conduct focus-group surveys with at least six villages 5. Conduct a pilot survey and sensory panels
Subasinghe: Lean Production Systems (Nigeria)	<ol style="list-style-type: none"> 1. Identify 20 farmers/processors to be “lean consultants” 2. Travel to Nigeria to conduct in-country training 3. Analyze initial data on lean management training 4. Continue to engage stakeholders virtually
McClanahan: Coral Reef Fishery (Kenya)	<ol style="list-style-type: none"> 1. Map fisheries in two remaining sites 2. Conduct training on stock assessment and enroll additional members of the community to participate in data collection 3. Monitor data collectors and resolve issues related to effort duplication and fish group identification 4. Commence data entry and analysis
Pincus: Nourishing Nations (Nigeria)	<ol style="list-style-type: none"> 1. MSU PhD student will defend her research proposal 2. Organize a key stakeholders’ meeting with the activity team, fisheries policymakers, and fish processors in Delta State 3. Hire and train enumerators to administer a pre-activity questionnaire, and commence data collection 4. Finalize recruitment of fish processors for training program 5. Complete a low-literacy nutrition education tool and business plan curriculum for training program 6. Complete development of survey and experimental protocols by MS students at University of Calabar 7. Commence market survey and fish sample collection for analysis 8. Implement first phase of training program

Ragsdale: FishFirst! Zambia	<ol style="list-style-type: none"> 1. Apply for ethical clearance from the University of Zambia 2. Develop and finalize fieldwork logistic plans, fieldwork protocol plans, and enumerator training protocols 3. Finalize protocols and undertake two literature reviews 4. Train enumerators in implementing the WEFI-FFZ, MDD WRA, and MDD-IYC 5. Collect and clean data; begin data analysis
Hok: Bighead Catfish (Cambodia)	<ol style="list-style-type: none"> 1. Process quotation to purchase materials of the wet lab 2. Install and operationalize the wet lab for aquaculture feed nutrition research at RUA 3. Conduct training of RUA personnel on the operation of a wet lab, including a visit to WorldFish Malaysia (if travel is allowed) 4. Start, maintain, and document the aquaculture feed nutrition research