



FEED THE FUTURE

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



FEED THE FUTURE INNOVATION LAB FOR FISH

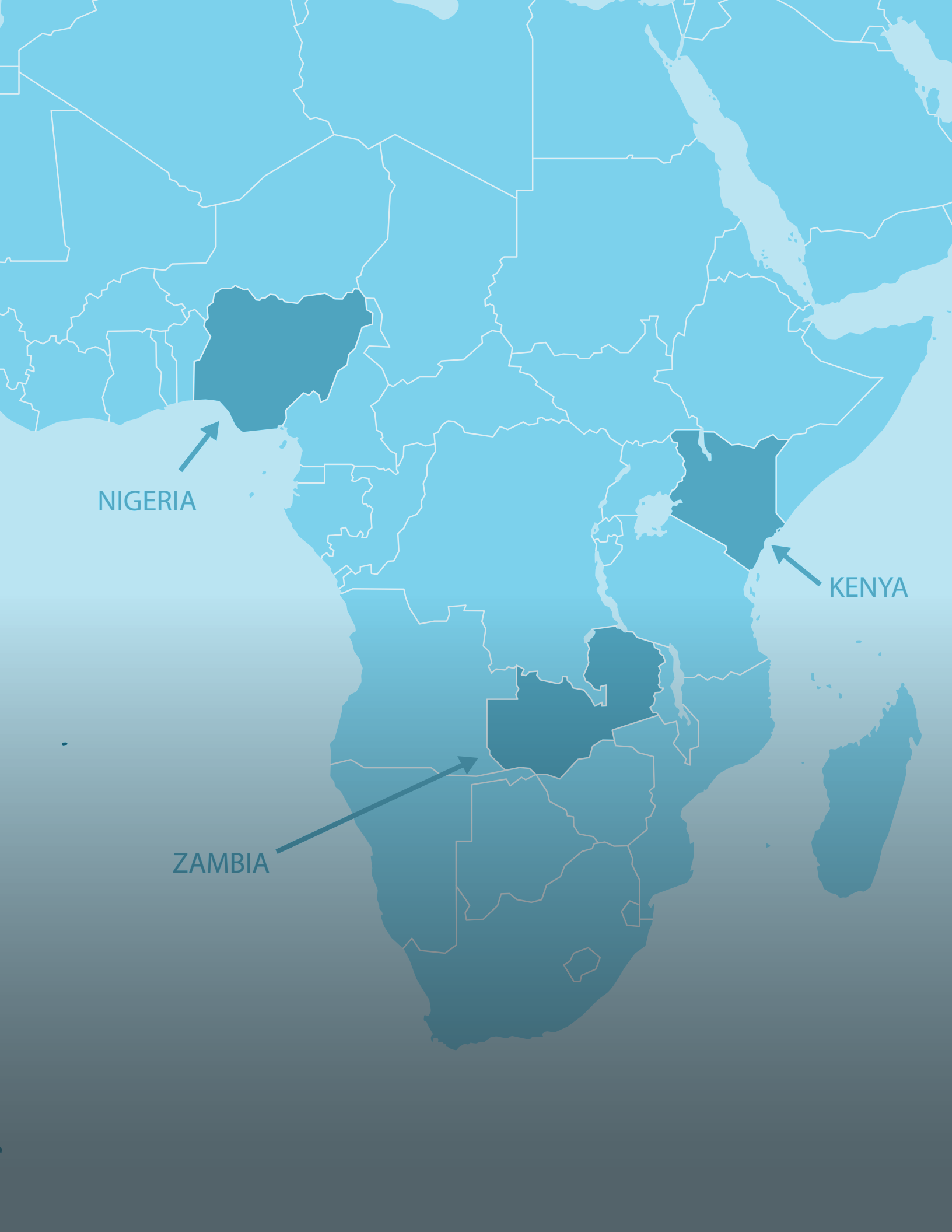
ANNUAL REPORT

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Katie G. Nelson



MISSISSIPPI STATE UNIVERSITY™
GLOBAL CENTER FOR
AQUATIC FOOD SECURITY



NIGERIA

KENYA

ZAMBIA



— ABOUT US —

Funded by the U.S. Agency for International Development, the Feed the Future Innovation Lab for Fish (Fish Innovation Lab) aims to reduce poverty and improve nutrition, food security, and livelihoods in developing countries by supporting the sustainable development of aquaculture and fisheries. To achieve these goals, the Fish Innovation Lab supports research and capacity-building activities targeting three program areas of inquiry and four essential cross-cutting themes.

AREAS OF INQUIRY

- **Advancing productivity:** Developing innovations to increase achieved yield of fish in aquaculture, improving availability and nutritional quality of feed (especially removal of fish meal and fish oil), improving genetics and reliability of fish seed, and enhancing sustainable fisheries management to improve harvest yields and increase reliability
- **Reducing and mitigating risks:** Increasing the tolerance of fish to biotic and abiotic stresses (including ecological resilience), improving diagnostic capabilities, maintaining healthy and bio-secure production environments, and reducing pre- and post-harvest losses (including ensuring food safety)
- **Improving human outcomes:** Identifying how aquaculture and fisheries can help improve nutrition and market opportunities (especially for vulnerable populations), equitable access to production assets (especially for women and youth), and establishing an enabling environment for fish production

CROSS-CUTTING THEMES

- **Mainstreaming Gender Equity and Youth Inclusion:** The Fish Innovation Lab promotes culturally sensitive, gender-transformative, and youth-inclusive research for development through the dissemination of knowledge, tools, recommendations, and promising practices that recognize and account for 1) multiple needs and roles of youth, women, and men in small-scale production marketing systems, and 2) multiple domains of influence that facilitate or constrain the participation of youth, women, and men in development and sustainable management along the fish value chain.
- **Advancing Human and Institutional Capacity Development:** Focusing on strengthening the capacity of host-country individuals and organizations, the Fish Innovation Lab efforts encompass the widening diversity of people and institutions that have a stake in fisheries-food-security outcomes and impacts. We mainstream capacity-development initiatives that build on a competency-based approach, which recognizes the value of both tangible and intangible aspects of capacity development. This approach allows us to strengthen development conditions across the fish value chain; promote community buy-in; and stimulate sustainability and scalability by supporting individuals and organizations to develop, manage, and own capacity-development and learning plans that lead to continuous improvement.

FISH INNOVATION LAB QUICK START PROJECTS

■ **Strengthening Resilience:** The Fish Innovation Lab funds research for development that increases resilience and reduces risk at different stages of the fish value chain and at the household level. Aquaculture and fishery systems are particularly vulnerable to extreme storm events, unusual fluctuations in temperature and rain, and anthropogenic stresses and shocks. The Fish Innovation Lab ensures that strengthening the resilience of these systems, and the resilience capacities of coastal households, is a feature of all projects in order to better prepare communities to address the grave challenges they face.

■ **Advancing Nutrition:** The Fish Innovation Lab aims to assess nutrition as both outcome and determinant and supports research to identify interventions that optimize human health and livelihoods while sustaining aquatic ecosystems over the long term. Through research in our three areas of inquiry, we delineate and ultimately impact multiple pathways to food security and human nutrition in vulnerable groups living in low-resource households and among smallholder fisher families: pregnant and lactating women; infants and young children; and school-aged children.



ANALYSIS OF THE AQUACULTURE POST-HARVEST CHAIN IN NIGERIA

US PI: Julius A. Nukpezah, PhD, Mississippi State University

US Co-PI: Joe Steensma, EdD, MPH, Washington University in St. Louis

Nigeria PI: Tran Van Nhung, PhD, WorldFish

This project aims to improve the contribution of aquaculture fish to the diet and household incomes of the Nigerian people. Geographic information system tools are combined with field assessments using mobile data-collection tools to better understand current aquaculture postharvest chain structure, efficiency, and key market constraints. This aquaculture postharvest assessment complements current work conducted by the Bill and Melinda Gates Foundation and WorldFish, and it will identify opportunities for designing investments for improving the overall contribution of aquaculture to the well-being of the people of Nigeria, including poor and vulnerable women. The goal of the project is to conduct a comprehensive analysis of the aquaculture post-harvest chain of Nigeria to better understand the fate of harvested fish from production to consumption.

Achievements: The cold chain analysis team organized and facilitated two workshops in Nigeria to develop a research methodology and the project workplan, with 22 participants total from universities, research institutions, the public and private sectors, and local institutions. Following the development of data-collection instruments and methodologies, the quick start team also organized a training workshop on survey tools for enumerators and supervisors on sampling design, use of online tools, and qualitative focus group-discussion methods. In total, 37 enumerators and nine supervisors were trained in how to use online data collection tools for survey implementation. A total of 1,699 individuals were interviewed in eight selected states in five regions. The quick start team also participated in a workshop aiming to develop a case study on the implementation of a new human and institutional capacity-development tool.

Lessons learned: Judging from the workshops organized in Nigeria, the quick start team learned that local university and research institution partners have the capacity to identify and resolve challenges in aquaculture production in Nigeria. Collaborating with existing institutions will contribute to increased adoption of aquaculture technologies introduced to farmers along the value chain. Furthermore, partnering with international nonprofit organizations, such as the Bill and Melinda Gates Foundation, via a project implemented by WorldFish, provided synergies to accomplish more than the project would have if it were acting alone in Nigeria. Collaborating with other agencies with different missions and goals provides lessons in managing boundaries to achieve bigger goals.

OBJECTIVES

1. Identify technologies and practices that provide income growth and improve diets, including post-harvest loss reduction.

2. Identify and map the aquaculture market systems that improve productivity and reduce post-harvest losses of aquaculture fish.

3. Identify gaps in the aquaculture post-harvest sector in Nigeria.



ASSESSING FACILITATORS AND BARRIERS TO AQUACULTURE AND FISH CONSUMPTION IN ZAMBIA (FISH4ZAMBIA)

US PI: *Kathleen Ragsdale, PhD, Mississippi State University*

US Co-PIs: *Mary Read-Wahidi, PhD, Mississippi State University*
Elin Torell, PhD, University of Rhode Island

Zambia PI: *Lauren Pincus, PhD, WorldFish*

Zambia Co-PI: *Pamela Marinda, PhD, University of Zambia*

Fish provide essential micronutrients and contribute to a diversified diet for millions of people in Zambia, yet undernutrition is a serious problem in the country, where 40% of children under the age of five are stunted. Fish are a unique animal-source food that is rich in protein and essential fatty acids. Small fish have particularly high levels of micronutrients, especially in the bones, head, and gut. Because small fish are often eaten whole, they provide high nutritional benefits, especially for pregnant and lactating women and children in the first 1,000 days. Research to assess how small fish reach vulnerable household members (e.g., infants/children, pregnant/lactating women) in Zambia is lacking. The Fish4Zambia quick start project includes 1) an assessment of existing fisheries enterprises disaggregated by key actors' gender and age to assess existing barriers and bridges to women- and youth-led fisheries development to pinpoint leverage points for growing this sector and 2) a fish-flow study of actors' engagement across the fish value chain. Results will inform the Fish Innovation Lab-supported postharvest value-chain activities, the USAID Zambia Mission, and the Government of Zambia investments in fisheries. This project contributes to Feed the Future objectives to understand why many Zambians (particularly women and children) continue to lack dietary diversity and remain vulnerable to food insecurity and malnutrition.

Achievements: The Fish4Zambia team held a kick-off meeting, and the team finalized a number of research instruments:

- Women's Empowerment in Fisheries Index (WEFI)
- Fish4Zambia Focus Group Discussion Guide for Men and Women (Ages 30+ Years)
- Fish4Zambia Focus Group Discussion Guide for Youth (Ages 18-29 Years)
- Fish4Zambia Key Informant Interview Guide for Ministry of Health (MoH)-NGO
- Fish4Zambia Key Informant Interview Guide for Ministry of Fisheries and Livestock

The data-collection tools were implemented in the Samfya District in Zambia. The team collected data via 397 WEFI surveys; seven men focus groups, nine women focus groups, and seven youth focus groups; Ministry of Health interviews, and one Ministry of Fisheries interview. The team also set up databases for the data collected, conducted a preliminary analysis of the WEFI surveys, and began developing the Fish4Zambia preliminary results report.

Presentations and Publications

Kolbila, R., Ragsdale, K., Marinda, P., Read-Wahidi, M. R., Pincus, L., & Torell, E. (2019, October). *Using Fish4Zambia preliminary results to explore food insecurity among men and women in Zambia's Lake Bangweulu region. Presentation at the Mississippi State University Graduate Research Symposium, Mississippi State, MS.*

Marinda, P., & Ragsdale, K. (2019, September). *Talent is universal; Opportunity is not: Why gender equity and youth inclusion are vital for aquaculture and fisheries development. Presentation at the Feed the Future Innovation Lab for Fish Virtual Platform Meeting.*

OBJECTIVES

1. Assess the current state of small fish (e.g., kapenta and chisense) capturing, processing, and trading activities from point of catch through processing to local and distant markets for sale in both rural and urban areas.

2. Identify the social and gender barriers to entry and/or participation in these value chain activities for the different actors, particularly women and youth.

3. Assess how small captured fish are accessed by different consumer groups and consumed within households, especially in households in rural and urban areas distant from their source of production.

4. Explore the potential of upgrading the small fish value chain via improving processing, storage, and trading methods to reduce post-harvest losses and improve food safety.

5. Explore the use of small dried fish for further processing into fish powder and incorporating into locally appropriate foods for enhanced nutrition of women and children in the first 1,000 days of life.



GENOME SEQUENCING AND DEVELOPMENT OF SNP MARKERS FROM ROHU IN BANGLADESH

US PI: Attila Karsi, PhD, Mississippi State University

US Co-PI: Dan Peterson, PhD, Mississippi State University

Bangladesh PI: Md. Samsul Alam, PhD, Bangladesh Agricultural University

*Bangladesh Co-PIs: Md. Akhtaruzzaman Khan, PhD,
Bangladesh Agricultural University
John Benzie, PhD, WorldFish
Matthew Hamilton, PhD, WorldFish*

Bangladesh is an excellent example of the contribution of aquaculture to food security and livelihoods due to the importance of fish as a dietary source of protein and micronutrients. Polyculture practices have incorporated carps, such as rohu, for many years and recently have included combinations with small indigenous fish species; however, improvements in broodstock selection are needed to increase the productivity of rohu. Broodstock selection has been initiated, and family lines have been developed at WorldFish, but the evaluation of beneficial traits is needed to optimize and accelerate targeted family development. This project is identifying challenges, possibilities, and needs of aquaculture in Bangladesh. Direct outputs include the evaluation of broodstock development, a high-quality genome sequence of rohu, and the identification of genome-wide SNP markers for broodstock selection programs. The research will be beneficial for informing selective breeding for additional carp species, such as silver carp and catla carp, and it will enable assessment of species impacts on pond productivity, which will reduce poverty and improve food security in Bangladesh.

Achievements:

Objective 1: The quick start project PIs, co-PIs, and collaborators developed a stakeholder survey questionnaire and focus group-discussion guide to collect farm-level data. A draft stakeholder survey was pretested with five rohu farmers and finalized. Three graduate students were selected as enumerators and trained for two days. The survey then was conducted by visiting 184 rohu farmers and 31 hatchery owners from the Mymensingh, Rajshahi, and Jashore regions. Data entry of the surveys completed by rohu farmers and hatchery owners is underway.

Objective 2: Researchers at Bangladesh Agricultural University collected blood samples from five male rohu carp and shipped the samples to the Institute for Genomics, Biocomputing and Biotechnology at Mississippi State University. The blood yielded high-quality DNA that was prepared for sequencing. Using Oxford Nanopore long-read sequencing, a rohu genome sequence was computationally assembled into scaffolds. The sequences of the assemblies were then improved by comparing the scaffolds with high-coverage, short-read sequences produced using an Illumina sequencer. Currently, a chromatin configuration sequencing technique called “Hi-C” is being used to join scaffolds into pseudomolecules (i.e., chromosomes). Bionano Optical mapping will be used to correct assembly mistakes and improve the quality of pseudomolecule assemblies.

Objective 3: The genotyping by sequencing analysis for SNP development is being optimized at the IGBB. After completion of genome sequencing and genotyping by sequencing work, bioinformatics analysis will be conducted for SNP discovery.

OBJECTIVES

1. Establish collaborations and conduct stakeholder surveys
2. Conduct sequencing of the rohu (*Labeo rohita*) genome
3. Identify genome-wide SNPs



IMPROVE NUTRITION AMONG VULNERABLE POPULATIONS IN KENYA THROUGH INCREASED ACCESS TO AND CONSUMPTION OF SUSTAINABLE FISH FOODS (SECUREFISH)

US PI: **Lora Iannotti, PhD, Washington University in St. Louis**

US Co-PIs: **Austin Humphries, PhD, University of Rhode Island**
Terezie Mosby, PhD, Mississippi State University

Kenya PI: **Andrew Wamukota, PhD, Pwani University**

Kenya Co-PI: **Elizabeth Kamau-Mbuthia, PhD, Egerton University**

Nationally representative data indicate low dietary diversity in vulnerable groups, and only a small fraction of young children were reported to consume any fish, meat, or poultry. Some of the most vulnerable people to malnutrition and micronutrient deficiencies are those along Kenyan lakes and coastlines, including infants and young children, pregnant and lactating women, and school-aged children living in poor households. Here, small-scale fishing has large-scale implications because it is essential to well-being via nutrient-rich food. This project will advise subsequent research initiatives to improve human welfare and nutrition using improved approaches to increase access to and consumption of coastal marine fish as food. Outcomes include a comprehensive inventory of coastal marine fish for food that maintain ecosystem functioning and address micronutrient deficiencies in vulnerable groups. It will yield insights into current household fish consumption and social dynamics in low-income households. The market analysis outputs will guide research on coastal marine fish species with potential as micronutrient sources, which will improve access and safety of household consumed coastal marine fish.

Achievements: The SecureFish team met in Nairobi and traveled to Mombasa for a study initiation with two objectives: 1) contact Kenyan government and NGO officials involved in the fisheries and aquaculture sector to solicit input on the research objectives and 2) begin the quick start project activities along the coast. The team met with local leaders in Kwale, Mombasa, and Kilifi counties.

Objective 1: Meetings with key contacts from government agencies and NGOs revealed there is high priority placed upon developing offshore fisheries. Challenges exist across the entire value chain, but stakeholders emphasized there is no capacity for fish processing in Kenya.

Objective 2: The team organized their experimental design around Beach Management Units and met with leaders of each unit who then facilitated discussions with fishers, fish traders, and households with small children. The quick start team adapted their planned survey questionnaire to incorporate information collected through dozens of such interviews. The team also visited a local health clinic to discuss nutrition communication in the villages and better understand health-treatment norms. Following the finalization of data-collection tools, data were collected (both fish marketing and household surveys) at four fishing communities (Vipingo, Uyombo, Shimoni, and Tiwi) and adjacent communities. The team also conducted key-informant interviews with community leaders and government officials.

Presentations and publications

Iannotti, L. (2019). *Innovative approaches to nutrition: sustainable animal source foods. Innovative Approaches to Address Nutritional Challenges in Sub-Saharan Africa, Africa Speak seminar series, Washington University in St. Louis, September 10, 2019. St. Louis, MO.*

Lawrence, M. (2019, September). *Improved nutrition security through increased access to and consumption of fish. Presentation at the Annual Meeting of the Feed the Future Innovation Labs, Washington, DC.*

OBJECTIVES

1. Identify nutritious coastal marine fish for food that maintain ecosystem functioning

2. Assess the acceptability and feasibility of these fish as foods for nourishing vulnerable populations of pregnant and lactating women, and young children

3. Determine market conditions for ensuring availability, affordability, and safety of these coastal marine fish as food



REPLACING FISHMEAL WITH SINGLE-CELL PROTEINS IN TILAPIA OREOCHROMIS NILOTICUS DIETS IN ZAMBIA

US PI: Delbert Gatlin, PhD, Texas A & M University

Zambia PI: Rodrigue Yossa, PhD, WorldFish

Zambia Co-PI: Rose Komugisha Basiita, PhD, WorldFish

Several ingredients have been investigated as alternatives to fishmeal in commercial aquatic animal feeds to support the sustainable growth of aquaculture globally. These alternative ingredients include, but are not limited to, insect meals and single-cell protein (SCP). SCP can be composed of yeast, bacteria, algae, or a combination. Zambia is unique in sub-Saharan Africa because it has high-quality, locally produced commercial tilapia feed from Skretting Zambia and Aller Aqua Zambia feed mills, which are both located in Siavonga next to Lake Kariba. The commercial tilapia feed in Zambia uses soy and fishmeal as protein sources; replacement of fishmeal has the potential to increase profitability and sustainability of tilapia aquaculture in Zambia. This quick start project will evaluate the potential of replacing fishmeal in tilapia diets with SCP products developed by Meridian Biotech, a company in the United States. Two products will be evaluated: MRD-Pro, which is a bacterial product, and DY-Pro, which is a yeast product. The quick start project will collect data to determine which product provides improved nutrition for tilapia and optimal levels of fishmeal replacement by evaluating growth, survival, nutrient utilization, and condition factor in tilapia. It will further determine potential health benefits of the SCP products by evaluating effects on gut health. This project will also provide institutional capacity development for Natural Resources Development College (NRDC) in Lusaka by improving facilities and building faculty expertise, and it will provide individual capacity development for participating NRDC faculty and students.

Achievements: Feed formulation was conducted, the SCP ingredient was shipped from Meridian Biotech to Texas A&M University, fishmeal was shipped to Texas A&M University from Aller Aqua Zambia (via WorldFish Zambia), and the feed has been produced. The quick start team worked with the staff of NRDC to purchase materials required to improve the aquaria and laboratory facility and plans to begin the fish trial experiment in December 2019. **Lessons learned:** When there is no established and functional animal ethics committee in the host country, the investigators should consider applying for IACUC approval at the institution where the US PI is affiliated. This may reduce delays in getting the research approved by a local animal ethics committee and allow the project to progress smoothly.

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OBJECTIVES

1. To study the effect of partial or total replacement of fishmeal by SCPs on the growth, survival, nutrient utilization, condition factor, and gut health in tilapia
2. To estimate the optimum level of substituting fishmeal with SCPs in tilapia diets
3. To determine which of the two SCP products tested is more appropriate for tilapia nutrition

MANAGEMENT ENTITY PARTNERS

The Fish Innovation Lab is managed by Mississippi State University, The University of Rhode Island, Texas State University, Washington University in St. Louis, and RTI International serve as management partners.

CORE MANAGEMENT TEAM

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Shauncey Hill, Program/Finance Manager, Mississippi State University

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ABOUT USAID

USAID is the lead U.S. Government agency for international development and humanitarian efforts to save lives, reduce poverty, strengthen democratic governance and help people progress beyond assistance.

ABOUT FEED THE FUTURE

Feed the Future is the U.S. Government's global hunger and food security initiative. With a focus on smallholder farmers, particularly women, Feed the Future supports partner countries in developing their agriculture sectors to spur economic growth and trade that increase incomes and reduce hunger, poverty and undernutrition. For more information, visit www.feedthefuture.gov.

ABOUT THE FISH INNOVATION LAB

Funded by USAID, the Feed the Future Innovation Lab for Fish aims to reduce poverty and improve nutrition, food security, and livelihoods in developing countries by supporting the sustainable development of aquaculture and fisheries.

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