

FEED THE FUTURE INNOVATION LAB FOR COLLABORATIVE  
RESEARCH ON AQUACULTURE & FISHERIES  
(AQUAFISH INNOVATION LAB)

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**GENDER INTEGRATION PLAN  
2013-2018: VOLUME II**

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## AQUAFISH INNOVATION LAB: GENDER INTEGRATION PLAN 2013-2018: VOLUME II

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The mission of the AquaFish Innovation Lab is to enrich livelihoods and promote health by cultivating international multidisciplinary partnerships that advance science, research, education, and outreach in aquatic resources. Bringing together resources from Host Country institutions and US universities, the AquaFish Innovation Lab emphasizes sustainable solutions in aquaculture and fisheries for improving health, building wealth, conserving natural environments for future generations, and strengthening poorer countries' ability to self-govern.

### **Cover Photo**

A member of the Chaza Cooperative Society in Tanzania shares experiences on pearl farming and crafting shellfish jewelry for extra household income.

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### **Disclaimers**

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## TABLE OF CONTENTS

<b>INTRODUCTION .....</b>	<b>1</b>
<i>Gender Equality and Equity.....</i>	<i>1</i>
<i>Gender Integration in Aquaculture and Fisheries.....</i>	<i>1</i>
<b>AQUAFISH PROGRAMMATIC GENDER STRATEGY .....</b>	<b>3</b>
<i>Alignment with Gender Goals of the FTF Initiative .....</i>	<i>3</i>
<i>AquaFish’s USAID-Approved Gender Integration Strategy .....</i>	<i>3</i>
<b>AQUAFISH’S USAID-APPROVED GENDER PLAN.....</b>	<b>7</b>
<b>AQUAFISH PROJECT STRATEGIES.....</b>	<b>8</b>
<b>ASIA PROJECT: BANGLADESH .....</b>	<b>10</b>
<i>Gender Inclusiveness Strategy.....</i>	<i>10</i>
<i>Gender Investigation.....</i>	<i>11</i>
<b>ASIA PROJECT: CAMBODIA &amp; VIETNAM .....</b>	<b>16</b>
<i>Gender Inclusiveness Strategy.....</i>	<i>16</i>
<i>Gender Investigation.....</i>	<i>18</i>
<b>ASIA PROJECT: NEPAL.....</b>	<b>23</b>
<i>Gender Inclusiveness Strategy.....</i>	<i>23</i>
<i>Gender Investigation.....</i>	<i>24</i>
<b>AFRICA PROJECT: GHANA &amp; TANZANIA .....</b>	<b>30</b>
<i>Gender Inclusiveness Strategy.....</i>	<i>30</i>
<i>Gender Investigation.....</i>	<i>31</i>
<b>AFRICA PROJECT: KENYA &amp; UGANDA .....</b>	<b>35</b>
<i>Gender Inclusiveness Strategy.....</i>	<i>35</i>
<i>Gender Investigation.....</i>	<i>36</i>
<b>LITERATURE CITED .....</b>	<b>40</b>

# INTRODUCTION

## GENDER EQUALITY AND EQUITY

Gender equality and female empowerment are core development objectives of the United States Agency for International Development (USAID) and are fundamental to accomplishing effective and sustainable development outcomes. Feed the Future (FTF) is the US Government’s hunger and food security initiative influencing current areas of focus in development, specifically aimed at hunger and poverty alleviation through agriculture development. Under the broad goal of improving the status of women in all areas of development, the FTF initiative emphasizes gender integration in the agriculture sector. Gender integration factors women into the planning, design, and implementation of a policy or program,

“Gender equality requires equal enjoyment by women and men of socially-valued goods, opportunities, resources and rewards.”

“Gender equity is the process of being fair to women and men.”

- UNFPA, 2014

and is also referred to as “gender mainstreaming” (UN, 2014). The early-stage approach of considering women within development objectives functions to improve fairness and operationalize gender equity.

The roles of women in global food production and in ensuring the nutritional wellbeing of their households are significant and extremely important, but they are limited by lack of access to opportunities and resources. According to USAID, women represent 40% of the global labor force, undertaking critical roles in agriculture and other fields; however, their potential to contribute to broad goals such as agriculture sector growth, improved nutrition, and climate change adaptation is

limited by unequal access to resources such as education, technology, loans, and land, as well as limited autonomy over earnings (Gown and Koppell, 2012).

In developing countries, women produce over half the food, bear most of the responsibility for household food security, and increasingly contribute to the household through income-generating activities. In recent years, women’s involvement in agriculture activities has expanded to meet increasing global food production demands. According to the United Nations, food production must grow by 70% globally to meet the demands of an estimated 2.3 billion additional people by 2050, most of who will live in developing nations (UN, 2013). As women are more likely to reinvest income in the welfare of their children, FTF-targeted investments in women are predicted to yield benefits across generations. Therefore, “reducing gender inequality and recognizing the contribution of women to agricultural productivity is critical in achieving global food security” (FTF, 2010).

## GENDER INTEGRATION IN AQUACULTURE AND FISHERIES

Gender integration is essential for the successful growth of the aquaculture and fisheries sectors, although inequality remains a barrier. In small-scale capture fisheries, typical gender roles involve men owning boats and doing the fishing, while women remain in charge of post-harvest activities such as processing and sales. In aquaculture, women are often found in mostly powerless and susceptible positions working as fry catchers, laborers, and as low paid workers at processing plants. According to the Food and Agriculture Organization (FAO) of the United Nations, women make up more than 19 percent of the primary fisheries and aquaculture workforce; however, when adding in people secondarily involved in the industry, women account for half of the workforce (FAO, 2016).

*Gender integration*, also referred to as “gender mainstreaming,” is a development strategy used to improve gender equity and equality through systemic inclusion and consideration of women.

- UNFPA, 2014

Women face lower wages and larger time commitments in the industrial processing sector and risk loss of traditional sources of income in the mechanization of small-scale fisheries production. According to the FAO, “gender discrimination stems from the low value attached to women's work and is perpetuated in their limited access to credit, processing technology, storage facilities, and training” (FAO, 2014).

In order to increase productivity and efficiency in the fisheries and aquaculture sectors, development programs need to identify and address elements of larger social and economic dimensions that are the root of complex development issues. Women and men need equitable access to assets and opportunities such as water resources, financial capital, knowledge of new production systems and skills, markets outside of regional gender boundaries, and participation in stakeholder groups and meetings. Providing equal opportunities for women and men is necessary for advancing economic and social development, not only for the benefit of fisheries and aquaculture, but also for the individuals and households that make up thriving communities.

Women are involved in every aspect of AquaFish work, from administration to research and education, as the program more broadly seeks to advance the development of responsible aquaculture technologies and systems through investment in research and capacity building. Since inception, disaggregated gender data derived from projects has informed continuing research, resulting in steady improvements in women's participation. Benchmarks are set and data are actively collected to track the involvement of men and women in leadership, training, and long-term degree programs. To achieve the highest potential value of aquaculture development, equal contributions of men and women are necessary. AquaFish continuously fosters this goal by laying the groundwork, year after year, for participation and leadership development for women.



Nepal training participants learn the benefits of culturing multiple species together.  
Photo courtesy of Madhav Shrestha.

# AQUAFISH PROGRAMMATIC GENDER STRATEGY

With a long-standing commitment to creating meaningful opportunities for both men and women in the aquaculture and fisheries sector of the developing world, the AquaFish Innovation Lab works to align its program-wide gender integration strategy with the current paradigms and initiatives in the development arena.

## ALIGNMENT WITH GENDER GOALS OF THE FTF INITIATIVE

The overarching goal of FTF is to sustainably reduce global hunger and poverty by tackling root causes to achieve large scale and lasting impact. Addressing the principal determinants of food security, the FTF initiative is focused on two primary objectives that encompass a number of target areas: 1) accelerating gender inclusive agriculture sector growth, and 2) improving nutritional status. According to the 2010 FTF Guide, coordinated investments in agricultural production (e.g., extension services and training) can increase the incomes of at least 40 million people worldwide.

To ensure that women are included in the development agenda in meaningful and equitable ways, AquaFish is committed to improving gender equality in the aquaculture and fisheries sectors to sustainably reduce global hunger and poverty. AquaFish is aligned with the FTF key objectives to accelerate inclusive agriculture sector growth and improve nutritional status. This is accomplished by implementing strategies to improve the livelihoods of smallholder farmers and fishers. The crosscutting work conducted under AquaFish involves stakeholders at all levels that emphasize gender equality, environmentally sustainable development, and sound natural resource management.

AquaFish focuses on small-scale agricultural producers, high quality seed, and best management practices. Increased access to these inputs is coupled with strategies to help ensure their safe and sustainable use. AquaFish investments in research and capacity building aim for women to have equal access to affordable inputs and improved techniques and technology. Our technologies are tailored to local conditions by supporting national research institutes and building local research capacity, including training local researchers and technicians. If gender inequalities inhibit demand, then these inequalities are addressed.

## AQUAFISH'S USAID-APPROVED GENDER INTEGRATION STRATEGY

*AquaFish's Gender Integration Strategy was approved by USAID as part of the AquaFish 2006 and 2013 Technical Applications, and as part of the Gender Plan that is on file at USAID and at the Management Entity. Approved by USAID in 2009 and March 2013.*

The degree of hunger within a society is in large part associated with the status of women – the family nutritional gatekeepers (Gardner and Halweil, 2000). Frequently, men must leave rural communities for wage employment in larger urban areas, leaving women with the responsibility overseeing food production at home. This trend has been termed the “feminization of agriculture” (FAO, 1998). Women have also assumed a leading role in aquaculture production in many cultures. FAO has determined that women farmers receive only five percent of all agricultural extension services worldwide despite their increasing role in food

**Where We Work:**  
The AquaFish Host Countries included below account for seven of the nineteen FTF Focus Countries.

Asia:

- Bangladesh
- Cambodia
- Nepal
- Vietnam\*

Africa:

- Ghana
- Kenya
- Tanzania
- Uganda

\*Not a current FTF Focus Country

production. Furthermore, extension programs rarely integrate women as part of the target audience, and policymakers have failed to recognize that men and women may be responsible for different crops and that information provided to men does not necessarily get passed on to women who need the information.

USAID policy requires that gender issues be addressed in all funded activities. AquaFish high impact strategies to integrate gender considerations include:

- Collecting disaggregated gender data throughout the implementation of the program and the individual research and outreach projects funded by AquaFish. These data are analyzed on an annual basis to gauge gender inclusivity success and take appropriate action as indicated through data analysis.
- Requiring that all funded projects address gender within their planned scope of work. Projects include a procedure for monitoring and evaluating gender integration as the project progresses with time. All projects must evaluate the effects of specific projects on gender and ensure that any possible negative effects on gender are mitigated.
- Promoting the participation of women in formal and informal education and training opportunities provided through AquaFish. Gender parity and equity are goals. AquaFish will set a 50% benchmark for training women in formal and informal education. Within AquaFish, 48% of the students educated through formal training opportunities have been women. This number represents a trend moving towards greater gender equality in recent years as access to a pool of talented women in developing countries is becoming deeper. In addition, women scientists and administrators are encouraged to participate in all AquaFish activities, as project researchers, advisory group members, and AquaFish Ambassadors to USAID Missions. Persistent pipeline barriers preventing women (former CRSP funded students) from moving upwards in their careers is also a topic under examination, with expectations for mitigative interventions.

In addition, AquaFish has been:

- Focusing one component of a lessons learned and synthesis assessment specifically on the social context and impact of AquaFish research and outreach activities on the lives of women.
- Tailoring specific extension and technical services related to sustainable aquaculture and aquatic resource management to women producers. In addition, extension specialists sensitive to diversity issues and access to resources of underrepresented groups and women are included as an integral part of their delivery team to ensure women farmers and fishers feel welcome in AquaFish training opportunities.

The FTF Women's Empowerment in Agriculture Index (WEAI), which measures the empowerment, agency, and inclusion of women in the agriculture sector, will aid AquaFish in identifying ways to overcome obstacles and constraints. WEAI measures the roles and extent of women's engagement in the agriculture sector in five domains: (1) decisions about agricultural production, (2) access to and decision making power over productive resources, (3) control over use of income, (4) leadership in the community, and (5) time use. The WEAI can be used for monitoring progress toward gender equality, which is one of the Millennium Development Goals. The WEAI was developed by USAID, International Food Policy Research Institute (IFPRI), and the Oxford Poverty and Human Development Initiative to track changes in women's empowerment levels that occur as a result of interventions under Feed the Future.

*Additional detail on gender strategies is provided in response to the 6 March 2013 USAID review of the AquaFish 2013 Technical Application (ref: qu. 4 and 5, 6 Mar 2013, USAID).*

In a 2011 UN FAO workshop on *future directions for gender in aquaculture and fisheries* in which AquaFish participated, direct advocacy for focusing attention on gender in the fish sector was recommended in order to achieve the level of awareness needed for stimulating policy actions, and for implementing and practicing gender mainstreaming. Women play a major role in the fish value chain, more often than not in the middle of the chain, regardless of whether it is a long export chain or shorter

local chain. Policy actions that favor either end of the chain or shorten the chain, for example, could marginalize women by damaging their opportunities to earn income and participate in the value chain. Experts suggest that policies need to attend to the needs of marginalized and vulnerable women's and children's groups. The empowerment of women throughout the value chain thus has been a focus of AquaFish and will continue to be a focus in the next Phase. In summer of 2012, during the transition period to Phase II, AquaFish organized an international session on Gender and Value Chains.

The session on Gendered Value Chains, organized by AquaFish CRSP in Tanzania in July 2012, brought together for the first time a set of high quality presentations on fish value chains in developing countries with a focus on gender. As one of the session panelists commented: "Women pervade fisheries in their roles as workers in fisheries, markets and processing plants and in non-fishery activities such as mothers who give birth to successors, as caregivers of the family, as connecting agents of social networks, among others and agents who share fisheries culture among the generations" (AquaFish 2012). In a multi-project case study, patterns at the intersection of gender and income/education show that less educated, resource poor women were concentrated in the low value end of the value chains; resource rich males and a limited number of educated, resource rich females occupied the upper end.

Access to resources was key in describing women's role in fishery value chains. Women are less engaged in modern value chains that have fewer nodes than the traditional complex and lengthier value chains. When women depart from fisheries to go to money earning positions elsewhere, the existence of local fishing cultures and industries are diminished. At present, in most developing nations, there appears to be limited distinction in the marketing of wild-caught fish and farmed fish and the two often share the same chain (AquaFish, 2012).

Good linkages are needed to improve information flow and learning capacities and also help to reduce transaction costs, increase productivity in terms of value, and increase profitability. Value chain collaboration then becomes very important for smallholder producers in developing countries to ensure access to new and profitable markets. Collaboration also allows participation in network governance to enable timely responses to end-user demands for capacity development and knowledge dissemination. Market access and value chain governance are commonly recognized as the key dimensions for creating opportunities for smallholder producers in developing countries. Addressing value chain issues in international development work involves efforts toward making local producers cost-competitive and also building capacity to enable them to comply with quality requirements, ensure consistent and reliable supply, and meet quality and safety standards. Opportunities for poor smallholder enterprises include cost-efficient market intermediate activities such as product aggregation, storage, processing, and distribution.

AquaFish's M&E plan, the Technical Application, and the RFP for subawards outline diverse on-the-ground interventions for making gender matter, with the expectation that devoting resources and attention to persistent issues can make a difference. For example, strengthening women's social, economic and political roles, power, voice and influence through human capital development, using strategic entry points (e.g., education), and enhancing and recognizing women's contributions in aquaculture and fisheries across the value chain are all critical first steps.

AquaFish has collected disaggregated data for long-term and non-degree, short-term training. Disaggregated data have been used to analyze unevenness in training opportunities and/or outcomes for women. Data showed that AquaFish was doing a highly effective job of reaching women in long-term training (48% of degree students are women). However, when the data showed that fewer women were being reached in Ghana and Kenya by short-term trainings than in host countries in Asia or LAC, interventions for reaching women with training opportunities (workshops, shadowing, etc) were specifically designed and implemented.



AquaFish requires that each competitive subaward project include at least one outreach activity that focuses on women and/or girls. In addition, external subawards will perform gender-focused programmatic research. Previous AquaFish research examined women's access to market information in the fishery sector, and helped the Kenyan Government analyze mobile information networks for women fish marketers. Access to market information and the nature of information flow has become a key requirement for maintaining competitiveness, for men and women. With increasing access to and use of the Internet and mobile communication devices, individuals in developing countries have the opportunity to effectively participate in value chains to be competitive. Supply chains for agri-food products also being driven by delivery and procurement conditions requiring timeliness, consistency and reliability, and the development of relationships. Those without access to these resources may find themselves in disadvantaged positions, and must be intentionally considered. AquaFish outreach to women has helped improve access to resources and information, through short-term training (e.g., on fish-farm record keeping for qualifying for loans), technology analysis (e.g., open fish marketing cell phone networks), and through highly effective long-term training. AquaFish will continue its work towards an understanding of the gendered divisions at each node of a value chain and how these shape outcomes and impacts of transformations within dynamic value chains.

Addressing the family as a productive unit while empowering women adds on to the previous discussion of the importance of promoting women in value chains. Value chains are dynamic and vary in terms of composition, relationships, information flow, market positioning, etc. In many of the analyses in the fishery value chain, the gender of the actors was found to be an important factor in terms of access to investment, trade goods, and information. However, gender does not act in isolation from other variables in the human dimension and is embedded in culture, family, and household structures. Policies that address gender equality must rest on the principles of economic empowerment of women throughout the value chain.

AquaFish research takes a systems approach and in so doing examines in what ways economic trends within the fisheries sector impact individual and household access to assets and activities that support livelihood strategies. Several AquaFish indicators use head of household as an identifier. In AquaFish research, head of household can be male or female, the latter usually requiring more intentional effort to reach because of a combination of reasons including competing demands on their time and their poorer access to information. AquaFish recognizes that involving family as a productive unit is key to improving livelihoods particularly of women and children. AquaFish undertakes specific interventions to empower women through information and access to networks and resources (e.g., training, lenders, seedstock); researchers also provide information to governments for aquaculture policy development considering effects on families, women, and marginalized groups.

The use of gendered value chains represents an important innovation in our understanding of the fishery sector and the impact of economic transformations on fishing/aquaculture communities and households in a given region. By extending this analysis to questions of livelihood provides a more nuanced understanding of how economic processes affect both the family as a productive unit, and individuals in particular ways. The dynamics of household economies include factors for livelihood strategies including current asset base and ownership, household size and composition characterization, education and skill levels, work identities, family ideologies, and entrepreneurial initiative. These factors contribute to shaping the particular livelihood strategies individuals, families, and households adopt.

## AQUAFISH'S USAID-APPROVED GENDER PLAN

*AquaFish's USAID-approved gender plan is on file at USAID and at the Management Entity. It was approved by USAID 29 Mar 2013. The Milestones and Benchmarks below are excerpted from the AquaFish Monitoring & Evaluation Plan, approved by AquaFish AOR, USAID on 9 September 2013.*

### *Gender Integration Milestones and Benchmarks:*

#### Year 1:

- (1) Require that all funded projects address gender inclusiveness within their planned scope of work.
- (2) Seek out USAID review of projects' gender inclusiveness plans and respond by improving plans prior to project implementation.

#### Years 2-5:

- (1) Collect disaggregated gender data from individual research and outreach projects funded by AquaFish.
- (2) Analyze disaggregated data on an annual basis to gauge gender inclusiveness success and take appropriate action as indicated through data analysis.
- (3) Involve field projects in monitoring and evaluating gender integration as the program progresses with time. Evaluate the effects of specific projects on gender and ensure that any possible negative effects due to gender bias are mitigated.
- (4) Focus one component of a lessons learned and synthesis assessment specifically on the social context and impact of AquaFish research and outreach activities on the lives of women.
- (5) Tailor specific extension and technical services related to sustainable aquaculture and aquatic resource management to women producers.
- (6) Engage extension specialists who are sensitive to diversity issues and access to resources of underrepresented groups; and women will be included as an integral part of their delivery team to ensure women farmers and fishers feel welcome in AquaFish training opportunities.
- (7) Promote the participation of women in formal and informal education and training opportunities provided through AquaFish. AquaFish has set a 50% benchmark for training women in formal and informal education. In addition, the 50% benchmark applies to attracting and retaining women scientists and administrators in all AquaFish activities, as project researchers, advisory group members, and managers.

### FTFMS Indicators disaggregated by gender:

4.5.2(6)	Number of individuals who have received US government supported long-term agricultural sector productivity or food security training			
		2007-2016 Actual	2017 Target	2018 Target
	Total	1,197	86	0
	Female	587	43	0
	Male	610	43	0
4.5.2(7)	Number of individuals who have received US government supported short-term agricultural sector productivity or food security training			
		2007-2016 Actual	2017 Target	2018 Target
	Total	7,319	393	0
	Female	2,648	196	0
	Male	4,668	196	0

## AQUAFISH PROJECT GENDER STRATEGIES

The AquaFish Innovation Lab requires that all funded projects address gender integration within their planned scope of work. All projects have a *Gender Inclusiveness Strategy* that was approved by AquaFish and USAID in September 2013, and updated in 2016. Each Strategy includes a procedure for monitoring and evaluating gender integration as the project progresses with time. All researchers are responsible for evaluating the effects of their projects on gender and ensuring that any possible negative effects are mitigated. Each project includes at least one investigation that is specifically focused on women or girls.

**Asia Project: Bangladesh** | Enhancing Aquaculture Production Efficiency, Sustainability and Adaptive Measures to Climate Change Impacts in Bangladesh

Project Partners: North Carolina State University (Lead US University), Bangladesh Agricultural University, Khulna University, Shushilan NGO, and Patuakhali Science and Technology University

2016-2018 Gender Investigation: *Better management practices for Mola-Prawn-Carp gher farming integrated with pond dyke cropping for increased household nutrition and earnings of rural farmers in Southwest Bangladesh*

**Asia Project: Cambodia & Vietnam** | Improving Food Security, Household Nutrition, and Trade Through Sustainable Aquaculture and Aquatic Resource Management in Cambodia and Vietnam

Project Partners: University of Connecticut Avery Point (Lead US University), University of Rhode Island, Inland Fisheries Research and Development Institute, and Can Tho University

2016-2018 Gender Investigation: *Enhancing Food Safety and Household Nutrition of Women and Children Through Aquaculture and Capture Fisheries in Cambodia and Vietnam in the Dry Season*

**Asia Project: Nepal** | Development of More Efficient and Environmentally Sustainable Aquaculture Systems for Nepal

Project Partners: University of Michigan (Lead US University), Agriculture and Forestry University, Nepal Agricultural Research Council, and Directorate of Fisheries Development

2016-2018 Gender Investigations: *Outreach to Increase Efficiency of Aquaculture in Nepal and Developing New Systems for Periphyton Enhancement in Farmers' Ponds*

**Africa Project: Ghana & Tanzania** | Aquaculture Development and The Impact on Food Supply, Nutrition and Health in Ghana and Tanzania

Project Partners: Purdue University (Lead US University), University of Arkansas at Pine Bluff, Virginia Polytechnic Institute & State University, University of Hawai'i Hilo, Kwame Nkrumah University of Science and Technology, Sokoine University of Agriculture, Western Indian Ocean Marine Sciences Association, and University of Dar es Salaam

2016-2018 Gender Investigation: *Enhancing the Functionality and Applicability of Fish Market Information System (FMIS) to Marine Artisanal Fisheries in Ghana*

**Africa Project: Kenya & Uganda** | Aquaculture Development in Kenya and Uganda: Advancing Cost-Effective Technology, Market Assessment, and End-User Engagement

Project Partners: Auburn University (Lead US University), Alabama A&M University, University of Arizona, North Carolina State University, University of Eldoret, Kenyatta University, Makerere University, and National Fisheries Resources Research Institute (NaFIRRI)

2016-2018 Gender Investigation: *Women in Uganda Aquaculture: Nutrition, Training, and Advancement*

The complete *Gender Inclusiveness Strategy* for each of the five AquaFish projects and work plans for the gender-focused investigations listed above are provided in this *Gender Integration Plan*. These are printed as submitted by the project researchers.

## **ASIA PROJECT: BANGLADESH**



ENHANCING AQUACULTURE PRODUCTION EFFICIENCY, SUSTAINABILITY, AND ADAPTIVE MEASURES TO CLIMATE CHANGE IMPACTS IN BANGLADESH

### **GENDER INCLUSIVENESS STRATEGY**

This project involves collaborative research with three female host-country investigators, including the HC Lead PI. They help set priorities and will be key to implementing project activities at Bangladesh Agricultural University. We firmly believe that female role models are crucial for attracting women into the fields of scientific research and outreach, and in their empowerment in promoting them in sustainable farming activities. We anticipate that around half of the graduate and undergraduate students who will be working on the project will be female (approximately 4-6 students). We will consider gender in all activities conducted within the host country as well as in the United States.

We continue to commit considerable effort in incorporating women into our activities, with high priority on the participation of women within host country institutes. A prominent role of women in farming households is to feed fish and maintain crops for household consumption. In investigation 3 we will provide training on best production practices to ~60 women and girls on food production that is directly consumed by the household. We will also be assessing women on household consumption of vegetables and nutrient-dense fishes as part of our program in integrating nutritious fish production with dyke cropping. Incorporating them into our AquaFish Innovative Lab activities will be essential for successful implementation of the proposed studies and for promoting better management strategies and household nutrition throughout Bangladesh. We will also survey commercial farms, workshop participants and community organizations in Bangladesh to ascertain and limit any potential constraints to the participation of women and minority ethnic groups in our workshops. We also anticipate involving 50 - 60% women farmers in on-farm trials in Investigation 4. With this and the workshop training we anticipate that > 100 women will benefit from our work aimed at reducing poverty and malnutrition.

Our research will also support research and extension experiences for undergraduates and graduate students where we expect, based on our track record, females to play a significant role. The US lead PI is actively involved in the Women in Science and Engineering program at North Carolina State University and the Wolfpack Women in Science Organization, organizations dedicated to promoting the number of women entering science programs and choosing science-related fields as a professional career choice. He currently mentors female PhD and undergraduate students who will be actively involved in the research proposed here. Although not financially supported by these proposed studies, the US lead PI will include additional independent research projects for women through the Fisheries and Wildlife Summer Internship Program, and the Howard Hughes and Beckman Foundation undergraduate research experience programs. Female students and technical staff have always participated in our studies and are among the intended beneficiaries of the proposed project. We anticipate that half of the 10+ students from the HC and US involved in this project will be female.

## GENDER INVESTIGATION

### *Better Management Practices for Mola-Prawn-Carp Gher Farming Integrated with Pond Dyke Cropping for Increased Household Nutrition and Earnings of Rural Farmers in Southwest Bangladesh (16HHI01NC)*

#### **Objectives**

1. Evaluate the effects of different fertilizers on production of prawn, *Mola* and carps in gher/pond polyculture systems.
2. To assess the comparative efficiency of prawn - gher/pond muds, mulch, and inorganic fertilizer on production of summer and winter vegetables in integrated pond dyke systems.

#### **Significance**

Wide use of integrated farming practices, including but not restricted to the production of multiple finfish, holds significant promise for increasing dietary nutrition, productivity, and profitability of farming households in rural Bangladesh (Lightfoot et al., 1990). In Bangladesh, rice and fish comprise the main diet of low-income families, particularly during the production season for these crops (Roos et al., 2007). Although integration of freshwater prawn (*Macrobrachium rosenbergii*) farming in seasonal rice/paddy fields (*ghers*) has been successfully implemented and serves as a significant source of income to coastal families, farmers typically sell the prawns produced to fetch higher prices in overseas markets, meanwhile family members (particularly women and children) remain malnourished from lack of complete protein, vitamins, and other minerals in their diet. The present investigation proposes to address this problem by promoting the use of the *Mola* (*Amblypharyngodon mola*) fish and seasonal vegetables in integrated aquaculture-agricultural systems and by evaluating the impact of different fertilizers on the production of these nutrient-rich foods as well as prawn and carps.

Child malnutrition continues to be a major public health problem in rural Bangladesh. Up to 38% of all pre-school children have vitamin A deficiency leading to night blindness and up to 55% exhibit signs of iron-deficient anemia (Micronutrient Initiative/UNICEF, 2004; West, 2002). These effects may be alleviated, in part, through consumption of small indigenous fishes, such as *Mola*, which have significantly higher concentration of vitamin A (~1900 IU, Thilsted et al., 1997) and micronutrient content than other commonly consumed fishes (e.g., carp). The *Mola*, a small fish with soft bones, is particularly favored in the diets of many people; however, consumption in the Southwest region is limited to those captured in local rice fields, rivers, and canals. Early experiments suggest that *Mola* can be successfully cultivated in the presence of other finfish cultivars (e.g., carp; Alim et al., 2004; Wahab et al., 2003). These fish are self-recruiting species, existing naturally in perennial ponds and other freshwater sources. Once stocked, *Mola* can reproduce within the gher or in drainage ponds and can be continuously harvested over the production cycle of carp or prawn allowing for home consumption. *Mola* feed primarily on phytoplankton and detritus, therefore no feed input is necessary. Additionally, their bacteria-enriched waste can be utilized to enhance prawn production. Similarly, carps also feed on natural pond productivity and hence can be grown without supplemental feeds. Moreover, combining species of different trophic levels can maximize nutrient utilization and decrease the potential for harmful phytoplankton blooms and poor water quality that leads to mortalities (Halver, 1984; Wahab et al., 2008).

In our previous Innovation Lab research, we found that *Mola* and Rohu carp (*Labeo rohita*) could be successfully incorporated into gher-pond freshwater prawn culture without effecting prawn yield. We actually found that prawn production was somewhat enhanced by presence of *Mola* and Rohu in polyculture. More importantly production of *Mola* and Rohu increased the consumption of these nutritional foods and provided additional income from sale at local markets by households who undertook the polyculture farming practice. The study suggested stocking two brood of *Mola*/m<sup>2</sup> in prawn-carp gher-farming systems was best for increasing production of the fish without affecting their growth or that of

other fishes. Molasses (30kg) and yeast (400g/ha) was used to fertilize ponds and our observations suggest it may increase production of protein enriched biofloc on the pond bottom and better buffer changes in pH that may occur with other organic or even inorganic fertilizers (personal observations, D'Abramo et al., 2009; New et al., 2010). Farmers are interested in understanding if this would be the best method for increasing prawn and fish production compared with inorganic fertilizers, which are commonly used for enhancing plankton for fish production (Javed et al., 1993; Qin et al., 1995; Jasmine et al., 2011; for review see Egna and Boyd, 1997). Therefore, this experiment will evaluate which method of fertilization; yeast/molasses, inorganic fertilizer, or the combination of the two would best promote production of prawn, carp and *Mola* and yield the greatest return on investment.

The advantage of integration of aquaculture with agriculture (Aquatic-Agriculture System -AAS) is that the nutrient rich pond muds and water derived from fish culture systems can be used for growing vegetables on pond dykes. It is an increasing trend for farmers to use inorganic fertilizer in Bangladesh and the country faces a large fertilizer deficit. Consequently, the share of imported urea has increased from 30% in 2005 – 2006 to 69% in 2010 – 2011 and the country is almost completely dependent on imports of triple super phosphate (TSP) and muriate of potash (MP) (Ahmed, 2011). By 2050, the country's inorganic fertilizer requirements will be higher and international fertilizer markets are becoming increasingly more volatile (Basak et al., 2015). Hence, use of pond muds may reduce the costs of crop production and can also improve the pond water quality by reducing the possibility of eutrophication. Pond muds from carp and tilapia production have proved to be potential fertilizer for the cultivation of seasonal vegetables in Northern Bangladesh (Wahab et al., 2001), but this had yet to be applied to the Southern regions of Bangladesh where prawns are grown on over 50,000 hectares and where seasonal water bodies (2.83 million hectares; flooded for 4-6 months) remain underutilized in Bangladesh (Kunda et al., 2008; DOF, 2012). Our recent Phase I project shows that pond mud yields higher production of two seasonal vegetables (gourd and spinach) over dyke soil alone. The better utilization of pond muds with mulching material like black polythene has the potential to further increase vegetable production and its benefit will be analyzed and compared with that of inorganic fertilizer in the proposed studies.

Among household members, women and children often suffer most from a lack of nutritious foods. One key element of this investigation, therefore will involve training of women and girls on nutrition and better management practices for producing foods. Their greatest contributions to farming are feeding and maintaining fish and growing vegetables (Belton et al., 2011; Apu, 2014). We will train women on how to conduct the studies, and provide them with best practices for improving production of fishes and crops, namely *Mola* and vegetables, that can improve household consumption of nutritious foods and provide additional income.

### **Quantified Anticipated Benefits**

1. We will determine whether organic (yeast + molasses), inorganic, or a combination of the fertilizers provide better production yields and economic returns for farming *Mola*-prawn-carp in gher/pond polyculture systems.
2. Proper selection and more efficient approaches to vegetable production using pond muds, mulch or fertilizer will be established.
3. Better management practices for cultivating nutrient-rich *Mola* and vegetables for family consumption will increase the dietary nutrition available for low-income farming households, especially for women and children.
4. Forty to sixty women and girls will receive direct, on-site instruction on nutritional benefits of integrated farming designs and on best-management practices for production of nutrient rich fish and vegetables for consumption.

### **Research Design and Activity Plan**

#### **Location**

This investigation consists of a series of two studies and training activities, which will be carried out on participating farms located in villages of Rangpur Union, Dumuria Upazila, Khulna District, Bangladesh and the surrounding region. Water quality, and both pond dyke soil and the pond mud of the proposed experiment will be analyzed at Khulna University and BAU, Mymensingh, Bangladesh, respectively.

### Methods

*Experiment 1. Evaluate the effects different fertilizers on production of prawn- Mola- carps in gher-pond polyculture farming systems.*

*Null Hypothesis 1:* There is no difference in fish/shellfish yield or benefits of applying organic and inorganic or their combination on Mola-carp-prawn gher-pond polyculture.

Most of the farming households practicing traditional prawn culture in gher systems minimize the use supplementary feeds for prawn/fish culture because of high investment costs (50-60% of the total cost), hence, application of the fertilizers is a critical component to increasing production of prawns and fishes. Here we will assess 3 different fertilizer applications in prawn-*Mola*-carp polyculture on the farms of 20 households such that each treatment group will be replicated 5 times. One treatment will apply molasses (30 kg/ha) and powdered yeast (0.4 kg/ha) that was used in our previous work demonstrating *Mola* and carps could be successfully integrated into prawn culture. A second will incorporate inorganic fertilizers using levels recommend for extensive or semi-intensive culture of fishes (4N:1P; 28 kg N/ha using Urea; 7 kg P/ha using triple super phosphate; see Egna and Boyd, 1997), and a third will incorporate both types of fertilizers at 50% of the application amount used in the other groups. A fourth treatment will have no fertilizer applied as a reference group. The design is as follows:

Parameter	T1	T2	T3	T4
Prawn ( <i>M. rosenbergii</i> )	2/m <sup>2</sup>	2/m <sup>2</sup>	2/m <sup>2</sup>	2/m <sup>2</sup>
Rohu ( <i>L. rohita</i> )	0.1/ m <sup>2</sup>	0.1/m <sup>2</sup>	0.1/m <sup>2</sup>	0.1/m <sup>2</sup>
<i>Mola</i> ( <i>A. mola</i> )	2/m <sup>2</sup>	2/m <sup>2</sup>	2/m <sup>2</sup>	2/m <sup>2</sup>
Fertilization application	0	Molasses + Yeast	Inorganic Fertilizer	50 % of T2 + 50% of T3
Replication	5	5	5	5

Nursery pond preparation for prawn will be done according to standard practices followed by farmers. Prior to gher drying, bottom mud will be excavated and ponds will be limed and filled. Juvenile prawn (*Macrobrachium rosenbergii*) will be stocked at a density of 2/m<sup>2</sup>, Rohu at 0.1/m<sup>2</sup>, and brood *Mola* at 2/m<sup>2</sup>. Fertilizers will be applied to ponds (average of ~50 decimal or 2000 m<sup>2</sup>; 1.0-1.5 m depth) fortnightly. Prawn will be fed with a commercial feed using a feeding tray at 10% body weight (bw)/day for 10 days, 7% bw/day for 10 days, 5% bw/day for 10 days and 4-2% bw/day for rest of the culture period. Feeding frequency will be twice daily in the early morning and evening. Fish and prawn will be grown out for six months. After 60 - 70 days *Mola* begin to self-recruit and hence can be harvested for home consumption. Partial harvesting of larger *Mola* will be encouraged beginning at day 75 and periodically throughout the remainder of the experiment. Number and weights of partially harvested *Mola* will be recorded.

Water quality parameters, including temperature, secchi disc (transparency), DO, and pH will be measured on the spot weekly, and total alkalinity, nitrate-nitrogen (NO<sub>3</sub>-N), nitrite nitrogen (NO<sub>2</sub>-N), ammonia-nitrogen (NH<sub>3</sub>-N), and phosphate-p (PO<sub>4</sub>-P) will be measured fortnightly.



During the six-month grow-out period, performance data (weights/lengths) for all species will be collected by monthly sub-sampling, followed by total yield assessment at the end of experiment. Significant differences ( $p < 0.05$ ) in water quality, total production yields (biomass), and prawn, *Mola* and carp production yields/growth will be determined by analysis of variance (ANOVA) using SPSS.

*Experiment 2. To assess the comparative efficiency of prawn- gher/pond muds, mulch, and inorganic fertilizer on production of summer and winter vegetables in integrated pond dyke systems.*

*Null Hypothesis 2:* There is no difference in yield or benefits of summer or winter vegetable production between the different pond muds from the fish polyculture treatments or different soil treatments.

Two activities will be conducted under this trial, one on summer and the other on winter vegetable cultivation on pond dykes. Pond muds derived from the different polyculture gher pond systems in Experiment 1 (T2-T4) will be evaluated for their effects on production of fruit vegetable crops over both winter (Okra or gourd) and summer (tomato) seasons. This will allow a determination on whether vegetable growth might be enhanced by a particular pond fertilization treatment (organic versus inorganic fertilizers or both combined) using both summer and winter vegetables. The effects of pond mud will be compared in the absence and presence of mulch (black polythene) and with mulch and inorganic fertilizer. Black polythene is generally effective in preserving soil moisture and it will help to reduce the cost of irrigation, labor cost of weeding as well as to reduce the effect of soil salinity in experimental plots and can be incorporated at relatively little cost. The third group will have additional application of inorganic fertilizer at half the recommended level used for crop production in soils whether on pond dykes or not (FRG, 2012). Use of inorganic fertilizer represents a growing practice of horticulture on Bangladesh homesteads but the treatment can represent a significant cost, so here we will evaluate if its addition provides any further benefits relative to its extra cost. The experimental design is as follows:

Vegetable	Pond Treatment Experiment 1	Soil Treatment 1	Soil Treatment 2	Soil Treatment 3
Summer Fruit: Okra or gourd	Pond T1	Pond mud	Pond mud + mulch	Pond Mud + mulch + inorganic fertilizer
	Pond T2	Pond mud	Pond mud + mulch	Pond Mud + mulch + inorganic fertilizer
	Pond T3	Pond mud	Pond mud + mulch	Pond Mud + mulch + inorganic fertilizer
Winter Fruit: Tomato	Pond T1	Pond mud	Pond mud + mulch	Pond Mud + mulch + inorganic fertilizer
	Pond T2	Pond mud	Pond mud + mulch	Pond Mud + mulch + inorganic fertilizer
	Pond T3	Pond mud	Pond mud + mulch	Pond Mud + mulch + inorganic fertilizer
Replicate Plots	3	3	3	3

Three replications will be done for each of the summer and winter activities, where total number of plots will be 3 replicates x 3 pond treatments x 3 soil treatments = 18. Plot size of the dyke will be 2 m x 2 m. The inorganic fertilizer will be applied according to the fertilizer recommendation guide (FRG, 2012).

Plant growth (plant height, leaf number, branching number) and flowering time, fruit yield parameters (tomato, gourd or okra), yield per plot and converted to per hectare and some nutrient quality parameters of vegetables will be collected in each season. Vegetables consumed by household will be recorded. A marginal cost-benefit analysis evaluating return on investment among the three soil treatments will be

done based on total production yield, input costs and value of crops. Differences among variables measured will be analyzed by 3-way ANOVA in SSPS.

A major element of this investigation is to empower women and girls on best practices for producing crops, namely fishes and vegetables, for household consumption or sale that require relatively little additional cash investment and that can enhance nutrition and income. It is well established that a key role for women and girls in household farming is to maintain fish or seafood crops and establish homestead gardens (Belton et al., 2011). Gardens on pond dykes are less susceptible to flooding and muds provide a good source of nutrients for vegetable production at minimal costs. Thus, the technologies developed from our previous project and here for *Mola* and dyke cropping offer excellent opportunities to work with women to increase household consumption of nutritious foods. We will work directly with women and girls in participating households in undertaking the studies. They will be trained by the PIs on all aspects of the experiment: the purpose and goals of the work, methodology, tracking inputs, cost accounting, consumption, marketing opportunities etc. They will be provided record keeping books to monitor feeding and fertilization inputs, their costs and sales, and consumption. This will be complemented by training sessions on nutrition, e.g. caloric intake, importance of balanced diets, and value of *Mola* and vegetables to the diet. Their food consumption will be monitored through a simple survey prior to and after the studies and relative to that of reference non-participating households (60 women and girl members total). Collectively the work will provide critical training on nutrition and best management practices for producing household foods in integrated AAS that can enhance the nutrition of women and children including an estimated 60 individuals from participating and non-participating households.

### **Trainings and Deliverables**

1. The findings from these experiments will be reported through the Technical Reports of the AquaFish Innovation Lab (FIR).
2. The results will also be reported in workshops (Investigation 5) and/or relevant conference presentations.
3. Approximately 60 women and girls will receive direct training on nutrition and best management practices for producing fish and vegetables for home consumption that can benefit to their wellbeing.
4. The management practices for improved gher-prawn/*Mola*/carp or gher-pond/dyke cropping found in the proposed studies will be disseminated to the wider farming community through workshops outlined in Investigation 5.

### **Schedule**

June 2016 to March 2017: Experiment 1

September 2016 to September 2017: Experiment 2

June 2016 to December 2017: Training

January 2018 to February 2018: Final Investigation Report

## ASIA PROJECT: CAMBODIA & VIETNAM



### IMPROVING FOOD SECURITY AND HOUSEHOLD NUTRITION THROUGH SUSTAINABLE AQUACULTURE AND AQUATIC RESOURCE MANAGEMENT IN CAMBODIA AND VIETNAM

#### GENDER INCLUSIVENESS STRATEGY

The previous AquaFish CRSP project identified that in Cambodia and Vietnam both men and women are actively involved in aquaculture and fisheries. Men are primarily involved in decisions of fish species to be raised, timing for stocking, buying fingerlings, netting, harvesting, and capture fisheries and fishing. Women are often involved in daily feeding, such as gathering agriculture by-products and manure and feeding fish. Women are also involved in small-scale processing, fish sauce production, and trading of fish. While women are invariably involved in many of the stages of aquaculture, targeting of women in extension is often problematic. Training activities and meetings often take place during the day when women are busy with household activities. Women may not travel between villages and do not have long periods of time available to attend training. In Vietnam, it was found that when women were involved in training in aquaculture, women were allowed to make more decisions in the management of aquaculture as a result of their acquired knowledge. According to the rural women, their husbands encouraged them to make more decisions in aquaculture management and this strengthened their position in the family.

Different strategies can be used to address these barriers. One strategy is the instrumental approach, which sees women as a vital force in aquaculture development, and focuses on the need to assist women so that they can be more involved and more effective in aquaculture activities. With this approach, women's access to credit, training and extension services are important to enable them to improve their skills and knowledge and increase yield. The other strategy is empowerment, which sees that improvement in women's situations can be achieved through information and skills development and by changing gender power relations in the household and in society. Women will be involved in on-farm participatory research activities as many carry out feeding activities. Women will also be included, and specifically targeted, in both informal and formal education and training outreach activities through gender specific methods such as women-oriented workshops and trainings and published materials targeted at women. Extension specialists will be trained to be more gender sensitive and to include both men and women in training. Women will be supported for BS and MS degrees at Cambodian and Vietnamese universities.

Dr. Tran Thi Hien of Can Tho University and Mrs. Hap Navy of the Inland Fisheries Research and Development Institute (IFReDI) will be critical for carrying out this gender strategy in each country. Five of the six investigations will have a gender focus and two investigations will specifically focus on women. Investigation 1 will involve a targeted survey of women undertaking differing roles in the fish value chain from producer to consumer. A vulnerability assessment at each stage of the value chain where women play an important role will allow for impacts and gaps to be identified. Adaptation strategies at individual, household, and community levels will be developed. Two hundred women will be informed through trainings and poster, leaflets, and factsheets on current and potential impacts of climate change on value chains and adaptation strategies. Investigation 2 will focus on training 35 women to improve the processing activities for added value of cultured snakehead products. In addition, snakehead farms in Vietnam operated by women will be selected to develop improved culture using formulated feed through on-farm training for 25 women in An Giang province. Investigation 3 will train 50 women from poor households in Cambodia on the engagement in and development of sustainable snakehead aquaculture to increase nutrition, income, and livelihoods, especially those from women-led households. Investigation 5 will assess the impacts of climate change on fish yield on fish consumption and food security of vulnerable populations, with the focus on women and children in Cambodia. At least 300 women will be

better informed through training and posters and leaflets on current and potential impacts of climate change on aquaculture and fisheries and corresponding adaptation strategies, including engagement in and development of sustainable aquaculture. Investigation 6 focuses on policy recommendations on impacts of climate change on nutrition, food security and trade and adaptation strategies, including vulnerable populations of women and children. Two hundred women will be better informed through video and posters and leaflets on food security and nutrition issues and household adaptation strategies. Gender specific activities of the project will be conducted with the Cambodia HARVEST project and WorldFish Center when possible and lessons learned on gender and engaging women in aquaculture from activities conducted by these two organizations will be integrated into this project.

Women long-term trainees: Cambodia (4 BS and 3MSc); Vietnam (1BS and 3 MSc)

Proposed short term trainings: Cambodia (10); Vietnam (2)

Number of women PIs/Co-PIs and Investigators: Cambodia (2); Vietnam (1)

### **Gender Inclusivity Benchmarks**

Benchmark year 2: engagement of farmers, including women, in research

Benchmark year 2: improved household access to high quality food, especially for women and children

Benchmark years 1 and 2: women will be targeted in participatory research and extension activities of the project

Benchmark years 1 and 2: both women and men will receive training through workshops; several train-the-trainers workshops will be conducted in Cambodia and Vietnam on snakehead aquaculture production systems and nutrition, economics and markets

## GENDER INVESTIGATION

### *Enhancing Food Safety and Household Nutrition of Women and Children Through Aquaculture and Capture Fisheries in Cambodia and Vietnam in the Dry Season (16FSV01UC)*

#### **Objective**

The objective of this investigation is to understand the food safety and nutrition security of women and children by analyzing the nutrient density of commonly consumed fish and other aquatic animals (OAAs) from capture fisheries and aquaculture and its products in the dry season and proposed wise nutritional recommendations for adaption options and strategies for improving household food security and nutrition of vulnerable women and children in Cambodia and Vietnam.

#### **Significance**

Population growth and other changing variables, such water flow (hydrology), sedimentation (nutrient transport), salinity, and other human activities (e.g., hydropower development dams) are said to affect fish production, livelihood opportunities, food security, nutrition and its implications for human health (MRC, 2009; Sriskanthan & Funge-Smith, 2011; and Halls, 2012).

The prevalence of malnutrition among women and preschool children (under age of five years) continues to be a major problem in Cambodia. The Cambodia Demographic Health Survey 2014 (CDHS, 2014) showed that a high level of protein/energy malnutrition among children under five years of age, with a stunting prevalence rate of 32% (severe stunting -3SD was 9%). The prevalence of wasting was 10 % (severe wasting -3SD was 2%) and the prevalence of underweight was 24% (severe underweight -3SD was 5%), (CDHS, 2014). The CDHS 2014 indicates that more than 4 in 10 mothers are anemic (about 43.9%) and an overall 53 % rate of anemia among children under age 5 years. The prevalence of vitamin A deficiency among women and children are a major public health problem (CDHS, 2014).

Based on the research of the third phase of the AquaFish Innovation Lab (2013-2015), fish and aquatic animals (frog, crabs, snails, and shrimp) are the second largest staple food for women and children in Cambodia with consumption of 145.3 g/women/year and 53 g/child/year in the rainy season, respectively, after rice (Bunthang et al., 2015). They form an integral part of the diet of millions of rural Cambodians. Poor households in particular, with little alternative food production capacity, turn to such sources not only for additional food for themselves as source of their food security, but also for their daily nutritional requirement and for sale to earn income. It is reported that these fish and aquatic animals, particularly small indigenous fish species, have high nutrient content and high bioavailability of micronutrients (Roos et al., 2003, 2006, 2007). Fish, OAAs and products are the major contributor of energy and nutrients from an animal source, providing more than three-fourths (80%) to the total animal protein intake of women in the rainy season (Bunthang et al., 2015). Fish, OAAs and products are also the major contributor to energy, fats, carbohydrate, iron, zinc, calcium, and vitamin A of women, and contributed 69.7%, 54%, 99%, 74.5%, 44.6%, 83% and 87.4%, respectively. Fish, OAAs and products are the largest contributor to the total daily energy and nutrient intake from animal food source, providing around 80% to the total animal protein intake, of children in Cambodia. Fish, OAAs and products were also the major contributor to energy, fats, carbohydrate, iron, zinc, calcium, and vitamin A, contributed 72.1%, 60%, 93%, 57.2%, 44.1%, 92.8% and 56.4%, respectively, in the rainy season (Bunthang et al., 2015).

The application of traditional food processing/preservation technologies in Cambodia dates back in the ancient times and these techniques are often used, especially fish (fermented fish, salted, smoked, fish sauces, and fish paste called “Prohoc”). These uphold the Cambodian cultural identity. Fish processing provides many with a continuous source of protein throughout the year. Moreover, the fermentation process of some foods have potential to improve its nutritional qualities, reduce anti-nutrients, decrease pH, increase minerals and provide potential pro-biotic effects through lactic acid bacteria.

The availability of fish and aquatic products in Cambodia should normally be adequate for a balanced diet, but productive capacity or purchasing power of many households is limited, and in these circumstances the diet become more restricted to fish. Trade and market impacts in production levels is said to be changed throughout the value chain such as reduced trade volume and values reduced export earnings and reduced livelihood opportunity and increasing malnutrition.

Seasonality, ecological zones, family size and food distribution among the family members, especially seasonal differences, are the influential indicators affected to food consumption pattern of Cambodian individuals and households especially women and children.

During the third phase of AquaFish Innovation Lab (2013-2015) the study of food and nutritional consumption on women and children in Cambodia was conducted in the rainy season under the UConn's Investigation 13HHI02UC. The recommendation provided from the final national workshop on 26 September 2015 at IFRaDI in Phnom Penh is that the study of food and nutritional consumption should be conducted in the dry season in Cambodia in order to cover the whole year. There are two major seasons in the Lower Mekong Basin region and they bring about change in food consumption patterns. During the wet season, there is an abundance of fish, while during dry season there is less fresh fish available and people use more processed fish products. This study will allow us to make comparisons of food consumption patterns between the seasons to better assess ways to improve nutrition for women and children. Moreover, information of consumed fish and other aquatic animals (OAAs) from capture fisheries and aquaculture on women and children in the Mekong Delta of Vietnam is limited. This investigation will focus on this issue. A better understanding of the food and nutritional consumption of women and children can lead to support for both the public and private sectors to increase trade and investment in aquaculture in the Lower Mekong basin.

### **Quantified Anticipated Benefits**

- Two Master (all females) and 3 Bachelor (all females) students will be involved in this investigation. The investigation will support for their university fee and theses.
- At least 6 IFRaDI and Cantho University staff will be involved in the survey such as the project preparation, data collection and training activities.
- At least 1000 IFRaDI/FiA and Cantho University staff, scientists, researchers, government officers and managers, and NGOs will understand the nutrition contexts especially in women and children in Cambodia through in series of consultation meeting/workshop; and sharing research result findings such as policy brief and technical report.
- At least 450 women and 450 children will benefit from the project by improving nutritional status through the proposed nutritional recommendations for adaption options and strategies in Cambodia and Vietnam.
- Many other people in the Lower Mekong Basin region will benefit from this project through sharing of research findings.

### **Research Design and Activity Plan**

#### ***Location***

Inland Fisheries and Development Institute (IFRaDI), Phnom Penh, Cambodia. The field activities will be undertaken in Upstream Mekong (Stung Province), Downstream Mekong (PoeumRour, Prey Veng province), and Tonle Sap area: (Thom province) in Cambodia; and An Giang province in Vietnam.

#### ***Methods***

The project activities are organized using a systematic, stepwise approach from collection of information on utilized and analyzed foods, followed by promotion and dissemination of the results, and development

of recommendation policy. The activities are conducted by a multi-disciplinary research team, using appropriate quantitative and qualitative research methods.

*Activity 1.* To assess food and nutrient intakes by women and children; and identify commonly consumed fish and other aquatic resources, aquaculture and its products in the dry season in Cambodia and Vietnam.

Stung Treng province (Upstream Mekong River); Prey Veng province (Downstream Mekong River); and Kampong Thom province (Tonle Sap Area) in Cambodia and An Giang province in Vietnam will be selected for study sites. The data collection will conduct in the dry season (November 2016 to May 2017). The target of the study subjects are women and preschool children (aged six months to five years old). Three hundred (300) eligible women and 300 eligible preschool-age children will be selected in Cambodia and 150 eligible women and 150 eligible preschool-age children will be selected in Vietnam by using simple randomized sampling from the four provinces. Dietary intake will be examined through face-to-face interview by using a single 24-hour food recall to estimate the amount of food that has been eaten in the past 24 hours (Bunthang et al., 2011). IFReDI will provide the dietary assessment survey training to Cantho University staff and support the survey activity. Food models will be used to identify food items that have been eaten by the subjects. All food and beverage consumed will be recorded using standard household measurement and electronic scale (precision to 0.1 g). The names of local dishes consumed will also be recorded. The amount of each food item consumed will be estimated from the real food models. Mothers will be asked to show the amount of food consumed by her child, which have then been weighed. All food item consumption of women and preschoolers will be converted to weight in grams and the nutrient content of the foods consumed computed by using the ASEAN Food Composition Table (ASEAN FCT, 2000). Included nutrients for evaluation will be energy, macronutrients (Protein, Carbohydrate and fats), and key micronutrients (i.e., iron, zinc, calcium, phosphorus and Vitamin A). The nutrient intakes of women and preschool children will then be compared to the Recommended Dietary Allowances harmonization in Southeast Asia (Barba, 2008; RENI, 2002.) to determine the level of nutritional adequacy of the food intake to estimate the amount of food that has been eaten. Letters to the village authorities informing them on the conduct of the survey will be sent at least one week before the actual survey. The data will collect by trained field enumerators. The training aims to educate field enumerators how to conduct dietary assessment by using the 24-hour food recall questionnaire; educate the interviewers to get familiar with fish species; reinforce the recall interviewers with exercise practices and pilot testing; and educate the interviewers to be familiar with questionnaire before data entry will be employed. Pilot pre-test questionnaire will be conducted in order to identify the potential problems encountered in questionnaires, questions and recall. A letter of the survey objective will be used to inform the local authorities on the conduct of the survey before the actual field work will be started. Questionnaires will be cross-checked by the members of the team for any missing pieces of information followed by data entry. Microsoft Excel 2013 and SPSS Statistics Version 20.0 will be used for data entry and analysis. Data coding, cleaning, and cross-checking will be conducted. Descriptive statistic will be used.

*Activity 2.* To determine the nutritional composition of nutrient dense fish, OAAs and their products that are identified as commonly consumed by women and children with a focus on macronutrients (protein and fats) and key micronutrients key micronutrients (iron, zinc, calcium, phosphorus and Vitamin A).

The selection of the commonly consumed fish species, OAAs and its products from the result of activity one will be analyzed the nutrient dense. At least 15 of commonly consumed fish species, OAAs, and its products will be analyzed. The selected samples of fish and OAAs will be randomly collected as fresh from different landing sites, local markets, fishermen, and farmers for nutrient-dense analyses, while processed samples will be randomly collected from different market and processors. Proximate composition will use standard methods (AOAC, 1990). Proximate analysis is a quantitative method for determining the macronutrients in food. This includes moisture, total ash content, crude fat, and protein.

Moisture will be determined by using a drying oven, ash in a muffle furnace, protein by the Kjeldahl method and fat by Soxhlet extraction. Key micronutrients will be determined by atomic absorption spectrometry or the standard analytical methods of Association of Official Analytical Chemist (AOAC, 1990). Phosphorus, iron, and calcium were also analyzed by AOAC (1990) methods, specifically the molybdovanate method for phosphorus, the hydroxylammonium method for iron, and the muricide method for calcium. The content of non-heme iron will be determined by the widely use ferrozine colorimetric method. Heme iron and complex-bound non-heme iron will be calculated as the difference between total iron and inorganic iron. Microsoft Excel 2013 and SPSS Statistics Version 20.0 will be used for data entry and analysis. The two-way analysis of variance (ANOVA) will be used for the comparison of nutrient density of different selected samples with the statistical significance will be tested using 5% level. The analysis will be conducted at the Industrial Laboratory Center (ILCC), Ministry of industry in Cambodia.

*Activity 3.* Provide recommendations for policy and strategy development for enhancing food security and nutrition of women and children in Cambodia and Vietnam.

Merely identifying the proposed wise nutritional recommendations for adaption options and strategies will not be sufficient to improve household food security and nutrition of vulnerable women and children in Cambodia and Vietnam. There is a need to provide this information to policy makers, government organizations, NGOs, vulnerable households, especially women and children, to be able to make informed and deliberate decisions on adaptation. As an investigation, the purpose is to generate new information, and disseminate and communicate information generated by the project. Specifically, science-based policy recommendations. This investigation will provide this information through a suite of different communication methods and approaches for each audience.

*Audience analysis.* The identification of target audiences such as policy makers, government organizations, and NGOs in the fields of fisheries and aquaculture and food and nutrition security as well as poor, rural households who produce fish, and vulnerable women and children.

*Project products.* The project documents will be reviewed to extract key messages to be presented in the communication products. There will be a scientific-based policy recommendation, two protect technical reports and factsheet in English and Khmer.

*Communication and dissemination strategy.* The communication strategy is a combination of approaches, techniques and messages to reach different audiences. This will be done through workshops and meetings as well as training of field staff, and home-based providing materials as nutritional education materials for women and mother.

## **Trainings and Deliverables**

### ***Trainings***

- Short-term trainings - IFReDI and Cantho University staff will be trained on dietary assessment by using the 24-hour food recall, fish species, food safety, nutrition, and data cleaning and entry. The training will be conducted at IFReDI, Cambodia and Cantho University, Vietnam. The training will be conducted between October-November, 2016;
- Long-term trainings-Two masters students and 3 Bachelor students.

### ***Deliverables***

The deliverables of this investigation will include (1) final technical report, (2) policy brief recommendation and (3) factsheet in English and Khmer.



### **Schedule**

April - May 2016: Project Design.

May 2016 - June 2017: Assess food and nutrient intake and identify commonly consumed-fish and other aquatic resources by women and children in Cambodia.

June 2017 - October 2017: Determine the nutritional composition of nutrient dense identified commonly consumed-fish and other aquatic resources, aquaculture and its products.

October 2017 - February 2018: Analysis of recommend policy strategy for women and children and the communication product outreach for improving women and children.

## **ASIA PROJECT: NEPAL**



### **DEVELOPMENT OF MORE EFFICIENT AND ENVIRONMENTALLY SUSTAINABLE AQUACULTURE SYSTEMS FOR NEPAL**

#### **GENDER INCLUSIVENESS STRATEGY**

Our proposed work in Nepal includes a variety of cultures and is conducted with a variety of collaborators. Women and children are the target of much of our research described earlier, and their nutrition is our major goal in this proposal. We intend to include the participation of women in our outreach by a number of appropriately targeted activities, including:

1. Producing outreach materials that can be understood by a broad spectrum of society in Nepal, and focusing on the issue that many residents are illiterate and therefore written communication is not likely to be successful;
2. Developing at least four women's fish farming groups to develop in-person outreach on household ponds and other aquaculture methodologies; and
3. Insuring that 50% of our workshop attendees are female. This may be difficult, due to generally low participation rates for women attending workshops in Nepal.

The production of appropriate outreach materials will be difficult, given the low literacy rates of our target groups. One method used to overcome this issue is actual ponds and hands-on experiences to educate women and children in pond aquaculture. Other methods will include the production of fact sheets, with visual rather than grammatical content, and use of video and oral methods to extend information at workshops.

Women play an important role in aquaculture and in nutrition of poor families. We are conducting research targeted at this segment of the population and hope to encourage women to further their part in aquaculture development. For the on-farm trials in Nepal, we will closely work with an NGO (Rural Integrated Development Society-Nepal), which has been promoting Women in Aquaculture for many years. As a result, many farmers involved in the on-farm trials will be women.

We will also hold many workshops during this project, and we will invite 50% women participants. Women may have difficulties attending workshops due to their responsibilities in the home, so it is important to do more than just invite them to attend. We will work with our collaborators to identify these barriers and make appropriate plans to overcome them in our workshops. Such changes may include the location of workshops, the length of time involved, and special arrangements developed to allow female participation.

Another objective for gender inclusivity is to involve women in all aspects of our research. This may be difficult in Nepal because the pipeline at present is largely composed of male scientists, and for that matter, it has relatively few trained professionals in the fisheries and aquaculture area of either gender. We are quite proud of the fact that the one female Ph.D. level scientist in aquaculture (Sunila Rai) was trained under funding from the previous CRSP project. To address this pipeline, we are targeting that half of the students involved in the project be female, and the list of graduate students identified so far (see table below) is 50% female. We are providing a number of graduate fellowships, including tuition costs, to Nepalese students and will focus these opportunities on female participants as much as possible. Funding for students in Nepal includes 1 Ph.D. for 2 years, 10 M.S. for 1 year, and 20 undergraduates for 1 year.

## GENDER INVESTIGATIONS

### *Outreach to Increase Efficiency of Aquaculture in Nepal (16HHI03UM)*

#### **Objectives**

1. To expand outreach on school ponds in villages, including provision of water quality testing kits for schools, expansion of school ponds to at least two additional communities, and outreach on aquaculture in general to the communities near our target schools.
2. To conduct surveys to determine recent changes in fish culture practices in rural areas of Nepal and the sources of information that led to these changes.

#### **Significance**

Research is critical in determining best practices and possible variations in aquaculture systems throughout the world and how they might adapt to local culture and conditions (Diana, 2012). However, research alone cannot be effective in changing paradigms in aquaculture communities. Outreach of research results and social interactions to advise local communities are also important in changing aquaculture systems to become more sustainable and more profitable (Diana et al., 2013). Such outreach can target key groups to begin education, with the ultimate goal of local practitioners helping each other improve their aquaculture systems. For aquaculture, direct outreach by government or non-government organizations is one effective tool, but organic spread of knowledge from practitioner to practitioner is at least equally effective (Tain and Diana, 2007).

Women play an integral role in the aquaculture and fisheries sectors all over the world. Although women's roles and responsibilities are changing in some countries, there are constraints that limit female participation in aquaculture (Egna et al., 2012). A few such constraints women face in aquaculture and fisheries are time availability and allocation, land ownership and access to water, credit, training, and labor. Lack of training opportunities can trap women in vulnerable and poorly paid positions with no prospects of advancement (FAO, 1998).

Nepal has diverse agro-climatic and socio-economic characteristics, but suffers from limited communication and transportation networks. Most Nepalese live in rural areas at subsistence or near subsistence level. Most of the protein consumed by the rural population comes from cereal grains. Cereal proteins are generally deficient in one or more essential amino acids and are not complete sources of protein unless taken with other protein sources. An additional concern is that people have a habit of consuming only one cereal grain at a time in Nepal. People in the Terai eat more rice, while those in the hills consume more corn. This tends to make their diets unbalanced in nutritional content. However, this diet may be made nutritionally superior by supplementing it with fish.

We developed a project using school ponds and education on the nutritional value and methods of aquaculture to help young people understand the value of fish production and consumption for their families. While many Nepalese attend school, most have only a primary school education, and about 68% of women are illiterate. Therefore, training must take these limitations into account, while still providing for information exchange (Kloebler, 2011). Schools remain the center for learning in a community. Having ponds in the schools produced a practical, hands-on message to the local population that fish are an important constituent to boost nutrition and, hence, residents became encouraged to build fish ponds of their own. This also helps build the capacity of teachers who could spread knowledge on the importance of fish in nutrition to parents during teacher-parent interactions, as well as educating students and adults on issues of environmental sustainability and nutrition.

We consider the results of our school pond project a great success. The construction and operation of these ponds was a very exciting event for the school communities. Often, a number of adults attended

events such as stocking and harvesting, as well as visits during our training exercises. In fact, the ponds were so popular, some neighboring farmers constructed similar ponds within a few months of our school pond construction, and the local people wanted advice and materials to construct a community pond on school property. Pre- and post-training evaluation demonstrated that there was a significant increase in knowledge of the students about aquaculture, with a median grade of <40% on the pre-test and of 61-80% on the post-test. Initial knowledge about the nutritive value and production system of fish was very poor, but by the end of the training, the knowledge of students on fish production and nutritive value of fish was significantly increased.

The school pond project, in addition to our earlier project on household ponds in rural communities, have both led to dramatically increasing interest in initiating aquaculture by local people, as well as expanding the program to other schools. We believe a project to continue outreach on school and household ponds and to advise local communities on aquaculture would continue to spread this knowledge and increase food production to poor rural communities. One objective of this proposal is to continue outreach on aquaculture to our target communities to further enhance our previous educational activities.

Since various outreach activities have been a major component of our work in Nepal, we believe it is time to evaluate the relative success of these activities. For this component, we intend to focus on locations where people have received training or on-farm experiments to improve local fish culture. These locations include the school pond communities, locations where we have conducted periphyton enhancement projects, and locations where we have helped in construction of household ponds. For these areas, we intend to conduct a survey to determine how many of our innovations have been included in the common culture practices of local people. We realize farmers may not easily implement changes in practice completely, but may make modifications to their production systems based on how they perceive the practice to improve their yield or profit. Hence, the third objective of this project is to complete a survey to determine recent changes in fish culture practices and sources of information the led to these changes in several of our target communities.

### **Quantified Anticipated Benefits**

We anticipate that at least 2 new school ponds will be built, 40 more students will be educated on the methods of fish farming, and 20 more women will receive training in fish farming and its role in household health. Finally, we believe our survey results will help identify successes in our fish culture experiments and help coordinate future outreach activities in Nepal.

Training of 40 students and 20 adult women through school pond programs at 2 schools. Added training on research techniques for at least five university students in Nepal.

### **Research Design and Activity Plan**

#### ***Location***

Public schools will be selected from schools requesting to add ponds to their facilities, most likely in the same areas as our previous pond program.

#### ***Methods***

- 1 *School Ponds:*
  - 1.1 A 200 m<sup>2</sup> pond will be establishment for two schools.
  - 1.2 Carps and tilapia will be stocked in each pond and the materials necessary to grow them will be provided to each school system.
  - 1.3 School students and teachers will receive regular training about pond construction and farming activities.
  - 1.4 Focal educational activities include: fish pond design; fish farming, including feeding, fertilizing, growing and handling fish; and nutrition education, including fish cooking and eating.

- 1.5 Each school in the program (including the four already possessing fish ponds) will receive basic water quality testing kits for incorporation in their teaching. Kits will include simple HACH tests for dissolved oxygen, alkalinity, and pH as well as Secchi disks and thermometers. Sufficient chemical supplies will be provided to continue service of these kits for at least 4 years.
- 1.6 Informal education activities include forming a women's fish farming group.
- 1.7 Two meetings and discussions on fish farming will be held with groups of women established at each new school.
- 1.8 Topics on fish farming will be extended, including managing pond depth, pond preparation, species choice, water color, fertilizing, feeding, growing, and harvesting of fish.
- 1.9 Topics on health and nutrition will also be extended, including fish preparation and the value of regular consumption.
2. *Outreach Survey:*
- 2.1 Four locations will be selected where various aquaculture enhancement programs have been conducted.
- 2.2 A survey instrument will be developed and submitted for IRB approval.
- 2.3 Surveys will be conducted at 50 households with ponds in each location.
- 2.4 Statistical Design, Null Hypothesis, Statistical Analysis: no improvements will have been implemented in pond culture among communities. Improvements identified will not be a component of material extended in outreach projects to the communities. Statistical analysis: Chi square.

### **Trainings and Deliverables**

- Training: About 40 secondary school students will learn about aquaculture through our curriculum and school pond program.  
 Approximately 20 women will learn about aquaculture and its role in household nutrition through our new women's groups at the same 2 schools.  
 Five undergraduate or graduate students will learn about extension and training through involvement in this project.
- Deliverables: New school ponds at two locations yet to be determined.  
 A survey questionnaire about success of various aquaculture extension done through AquaFish in Nepal.  
 One fact sheet on school ponds.

### **Schedule**

Establish ponds and women's groups: 1 October through 1 December 2016. Class use of ponds: 1 September 201 through 1 June 2017. Survey data collection: 1 April 2017 through 1 December 2017. Final report will be completed no later than 28 February 2018.

### **Objectives**

1. To identify other possible methods besides bamboo rafts to enhance periphyton growth in ponds while not interfering in harvest systems.
2. To field test the most promising of these methods for periphyton enhancement in ponds in additional on-farm trials.

### **Significance**

The government of Nepal (GoN) has recognized that chronic malnutrition is a major problem in the country. The most common forms of malnutrition include undernutrition (insufficient energy) and deficiencies of vitamins and minerals, particularly vitamin A, iodine, and iron. About 41% of children less than 5 years of age are stunted (UNICEF, 2012a) and 48% are anemic (MoHP, 2006). With the nutrition problem, there is a need to develop environmentally sustainable and cost-effective food production systems that function year-round to provide adequate nutrients and improve household income for rural poor farmers. Our research activities in Nepal have targeted local women for improvements in household and larger scale fish pond production. In Nepal, men from poorer rural areas are often forced to seek employment outside the home (often even outside the country), and women are left to maintain the household and care for the family (Bhujel et al., 2008). As a result, most of the ponds developed for household aquaculture are managed by women.

Since 2008, the Institute of Agriculture and Animal Science (now the AFU) has promoted an innovative and environmentally sustainable fish production system of “Carp-SIS polyculture” to improve nutrition of poor women and children in Terai (Rai, 2012, 2013). The approach includes increased intake of small indigenous fish species (SIS) to improve health and nutrition of women and children. SIS are self-recruiting in aquaculture ponds, after initial stocking or colonization from natural waters, and can be harvested weekly and biweekly, favoring regular household consumption. A carp-SIS polyculture system also provides additional income through the sale of surplus fish. Addition of SIS to the carp polyculture system raised fish production above the national average, doubled consumption rate of household members, and provided Rs. 3,025 income per household in 270 days, which helped families become economically empowered (Rai, 2012).

We have done considerable research to help improve the carp polyculture system in Nepal by introducing new species (especially SIS, tilapia, and sahar) and by enhancing pond production by providing substrates for colonization of periphyton. As periphyton removes nutrients from the water and adds oxygen as it grows, it also cleans water being discharged from ponds and improves environmental performance. Since rohu, catla, and common carp are periphyton feeders (Rai and Yi, 2012), their growth and production are enhanced in ponds with added substrate for periphyton colonization compared to ponds without substrate (Azim et al., 2002; Rai et al., 2008). We recently completed a series of trials in on-station and on-farm experiments. These experiments showed dramatic increases in net fish yield (27%) and profit (74%) in on-station experiments. For on-farm studies, total fish production and gross margin were 19.3% and 151% higher in the carp+SIS+substrate treatments with 50% feeding than in carp polyculture with 100% feeding. Reduced feeding that is possible when periphyton is enhanced is not only economically more viable but also enhances environmental performance, as the water quality in ponds is generally higher and effluent released on draining for harvest is not as damaging. However, the on-farm work also identified some problems with our periphyton system. We used fixed rafts of bamboo covering about 1% of the pond area as a substrate for periphyton growth, but culturists believe these structures interfered with harvesting of fish, although on the positive side, they may also have provided hiding places for fish to avoid predation by birds, since survival of some carp species was higher in substrate ponds. Further outreach on this system, including meetings with farmers and testing of alternative periphyton enhancing substrates, is the main objective of this investigation. Some possible methods might include using

portable and floating substrates or ones that could be lifted from the water or pond during management activities. Since these issues were identified by farmers, we intend to hold two workshops to meet with farmers and identify their best ideas to develop periphyton substrates that will minimize disturbance to their operations. We then plan to field test the various methods identified in farm ponds.

The economic value of periphyton enhancement includes the ability to grow fish faster under similar inputs, as well as the ability to reduce inputs of feed and achieve similar growth rates. However, our previous trials included both periphyton enhancement and feed input reduction together. We have not tested reduced feeding without periphyton enhancement, and thus the gain in profit by reduced feeding has been included in the benefit of periphyton enhancement in our studies to date. We need to also separate these two management activities so we can clearly understand the importance of reduced feeding compared to periphyton enhancement in polyculture systems.

The purpose of this study is to assess 2-3 alternative periphyton enhancement methods identified by farmers in farm ponds with polyculture of carps and SIS in two locations of Nepal.

### **Quantified Anticipated Benefits**

We anticipate that our workshops will identify new methods for periphyton to be enhanced in ponds, and about 40 farmers will adopt these systems after testing in on-farm trials. We will also hold a workshop for government personnel and farmers to extend the results of these experiments to these user groups.

### ***Deliverables:***

Extension of periphyton enhancement to 20 farms through on-farm trials. Education of another 40 women will be done with a workshop to non-adopting farmers and 20 extension personnel during a workshop for government personnel, extending the results of our periphyton work. At least 5 graduate or undergraduate students will be involved in some aspect of this research, also enhancing their educational and research experience.

### **Research Design**

This experiment will evaluate increased yield of carps and SIS as a result of enhancing periphyton production, and will also determine improvements in water quality as a result of periphyton treatments.

f.1. **Location:**

On-farm verification of the best system will be tested in farmers' ponds in two districts; at Majhui, Chitwan and Kawasoti, Nawalparasi.

f.2. **Methods:**

f.2.1. Workshops: Two workshops will be held: one in Majhui and one in Kawasoti. At the workshops, farmers from the region that have been involved in previous periphyton studies will be asked to propose better alternatives for periphyton substrates in ponds. These alternatives must be environmentally responsible, including the materials used for colonization. The best alternatives will then be determined by voting of all attendees for all alternative designs suggested. Probably 2-3 alternatives will be selected for future testing, but the number are currently uncertain.

f.2.2 **Experiment:**

f.2.2.1 Culture period: 6 months for on-farm trials, SIS monitored for 12 months.

f.2.2.2. Test species: carps (common, silver, bighead/catla, grass, rohu, mrigal) and SIS (dedhuwa and pothi)

f.2.2.3. **Stocking and Treatments**

Stocking size: carps (5-10 g), SIS (2-5 g)

2-3 periphyton enhancements will be tested in multiple ponds

Additionally, a control with reduced feeding and no periphyton enhancement will be tested.

Besides the substrate systems tested, the inputs will be:

(1) Carp polyculture (15,000/ha) + SIS (50,000/ha) with 50% feeding (control)  
(2) Control + substrate (covering 2% of pond surface area) with 50% feeding. There will be multiple versions of these treatments, including various substrate enhancements identified in the workshops.

Overall production levels, fish size, and SIS yield will be evaluated for each farm by record keeping during harvest. Growth and production will only be assessed over the whole grow out season. Weight will be measured on 20 individuals of each species at stocking and harvest. Total harvest biomass will be measured for each species.

- f.2.2.4. Nutrient input: feeding (for reduced rations) will be done 6 days per week with dough of rice bran and mustard oil cake at 1.5% BW for most carps and grass to grass carp at 50% BW. Carp and SIS will be fed with freshly made dough of mustard oil cake and rice bran (1:1). Grass carp will be fed daily with locally available grass at 50% body weight. Fertilization will be done biweekly at 0.4 g N and 0.1 g P m<sup>-2</sup>day<sup>-1</sup> with di-ammonium phosphate (DAP) (18% N and 46% P<sub>2</sub>O<sub>5</sub>), urea (46% N) and farm yard manure (FYM). DAP and urea input at 700 and 940 g, respectively, and FYM at 60 kg for a 200 m<sup>2</sup> pond.
- f.2.2.5. Water management: maintain at 1 m deep.
- f.2.2.6. Water quality will be measured at stocking, mid-point, and harvest by project personnel. Parameters will include Dissolved Oxygen, SDD, and temperature will be measured as close to dawn as possible on each date. Periphyton colonizing substrates will be identified to species by microscopy and quantified for relative abundance at the beginning, middle, and end of the experiment in each pond.
- f.2.2.7. Farm visits will be made to each location at stocking, mid-point, and harvest to evaluate record keeping as well as to make measurements of fish and water quality variables.
- f.2.2.8. Statistical design, null hypothesis, statistical analysis:  
Statistical design: Completely randomized design (CRD)  
Statistical analysis: Multiple ANOVA  
Null hypothesis: There are no differences in growth, production, gross profit margin, and partial harvest among different polyculture systems (control, different periphyton substrates).

### **Schedule**

Periphyton workshops: 1 October 2016 through 1 January 2017. On-farm trials: 1 May 2017 through 1 December 2017. Final report will be completed no later than 28 February 2018.

### **Trainings and Deliverables**

- Training: Twenty farmers will learn periphyton enhancement techniques through on-farm trials.  
Forty women will learn about this technology through a workshop.  
Twenty extension personnel will also be trained on the technology through a workshop.  
At least five graduate or undergraduate students will be trained on research methods by involvement in these trials.
- Deliverables: Two workshops to determine alternative periphyton technologies.  
One workshop on periphyton technology results.  
One fact sheet describing this technology.  
One final report and hopefully one research publication after the end of this grant period.



# **AFRICA PROJECT: GHANA & TANZANIA**



## **AQUACULTURE DEVELOPMENT AND THE IMPACT ON FOOD SUPPLY, NUTRITION, AND HEALTH IN GHANA AND TANZANIA**

### **GENDER INCLUSIVENESS STRATEGY**

Women constitute a significant portion of people involved in fish marketing in Ghana and Tanzania. Women play the role of middle women, fish vendors, and restaurants owners. Men, on the other hand constitute a greater proportion of fish farmers. Culturally in Ghana and Tanzania, men usually do the farming and women do the marketing. Consequently, this proposal seeks to provide equal opportunities for women because a directed involvement of women is one of the keys to advancing economic and social development, not only in aquaculture, but on a holistic household and family economy. Data collection for Investigations 1 and 3 will involve the whole value chain, and subjects will include women household respondents to enrich information collected on the various chain actors and the gender roles. In particular, females will be targeted to respond to chain activities relating to fish processing, trading, and home cooking for consumption. At least 80% of respondents to be interviewed in the aquaculture chain involved in post-harvest activities will be women. This will ensure active participation of women in the data collection process.

Separate training activities targeting women will be accomplished in two investigations. Because of the role women play in the post-harvest sector, targeting them for training will improve aquaculture productivity and value chain efficiency through a more organized tilapia market data compilation, better coordinated marketing intelligence information, and access to market information to help the women make business decisions. The same recruiting effort will be applied to other investigations because the shellfish farming is a natural activity for women to adopt since they are already familiar with many bivalve species due to their reef-gleaning activities. The target for two investigations is 100% women living in eight coastal villages on the Fumba Peninsula of Zanzibar. The work will involve working with women's organizations in Zanzibar, including the Western Indian Ocean Marine Sciences Association (WIOMSA).

In addition to the inclusion of women in short term training activities, women are also being recruited for long term training at all the institutions involved in this project. The goal is to have 100% women recruited for any graduate studies in US institutions and at least 50% of bachelor's and master's level students who will be funded under this project in the host country institutions. The intent of this project is to ensure maximum participation of women in all the training, educational activities, and opportunities proposed herein. Female Fisheries Officers, who serve as aquaculture extension agents, fish farmers, course instructors, and students, will be actively recruited to participate in this project. We have demonstrated this inclusivity in the past through the selection of participants in the AquaFish CRSP short courses we have offered, as well as in the selection of students supported in graduate programs. We shall not apologize for deliberately going out of our way to select clusters that have more women representation in this project. Past experience shows that similar projects have had more impact when women are represented and are provided with opportunities to advance themselves.

## GENDER INVESTIGATION

### *Enhancing the Functionality and Applicability of Fish Market Information System (FMIS) to Marine Artisanal Fisheries in Ghana (16MER01PU)*

#### **Objectives**

1. Broaden the applicability of existing FMIS to include the marine artisanal fisheries subsector.
2. Expand the functionality of the FMIS by customizing market price collection procedures to enable accurate and real time data collection.
3. Train marine artisanal fishermen on the use of the FMIS.

#### **Significance**

During the 2013-2015 funding cycle, AquaFish Innovation Lab funded an investigation that developed a cell-phone based Fish Market Information System (FMIS) with a focus on tilapia and catfish in Ghana. This is because tilapia and catfish are the dominant fish species that are farmed and caught in inland waters. The FMIS has a database of current farm-gate and market prices of the two species in selected locations in Ghana assembled by fisheries officers and selected agents. The FMIS is web-based and provides market information on the two species on-line as well as via voice and SMS/text messaging to users. There are two types of subscribers to the system – registered users and ad-hoc users. The system can send out (push) farm-gate and market price information to only the registered users. However, to request (pull) information on tilapia prices from the system, both registered users and ad-hoc users can access the system either by dialing or SMS/text messaging to a 10-digit phone number or a 4-digit short code. The voice feature of the system when a user requests for information includes messages in English and three native languages – Twi, Ga and Ewe.

AquaFish CRSP and AquaFish Innovation Lab activities in Ghana over the years have addressed only aquaculture issues and not the capture fisheries sector. This investigation seeks to address the biased focus on aquaculture as the artisanal fisheries sector contributes significantly to seafood supply in Ghana. AquaFish Innovation has also funded a cell-phone based project in Uganda, that developed baseline information about the needs and interest of fish farmers that could be used by public agencies, NGOs, and cellular providers to develop services for fish farmers. In Kenya, the Kenya Marine and Fisheries Research Institute's (KMFRI) Enhanced Fish Marketing Information System (EFMIS) was piloted with a select group of fish farmers. Fish farmers were trained to query the EFMIS database to enable them become familiar with how the system worked, i.e., how to access Lake Victoria's fish landing information. This investigation will leverage the knowledge gained from the AquaFish funded Uganda and Kenya projects through collaborative work so that the countries can learn from one another in the development of this technology for the aquaculture sector. If well developed and implemented, the cell phone technology can improve the livelihoods of fish farmers and agents along the fish value chain by narrowing market information gaps and improving networking along the chain. With improved communication along the fish value chain, there would be better market efficiencies and reduction in transaction costs. This would result in improved incomes and household purchasing power for fish farmers and fish retailers. With more incomes, these households can afford to buy more nutritious foods to improve household health.

The UN Millennium project included eight development goals that committed nations to global partnerships to reduce all aspects of extreme poverty including income poverty, hunger, disease, lack of adequate shelter, and exclusion, while promoting gender equality, education, and environmental sustainability. Though the Millennium Development Goals (MDGs) do not make specific reference to fisheries and aquaculture development, those sectors are targets for development to alleviate hunger (MDG #1) and address environmental sustainability issues (MDG #7).

There are two capture fishery sectors in Ghana: marine (sea and lagoons) and inland (lakes, rivers and reservoirs). The marine fishing industry has three main sectors: Artisanal or small scale, semi-industrial or inshore, and industrial subsectors. The artisanal fisheries sector is the most important in terms of landings and contributes approximately 80% of the total marine fish production (Mensah & Antwi, 2002; Amador et al., 2006). The artisanal fisheries sector is reported to employ about 20% of the nation's labor force, or about 2 million people (Atta-Mills et al., 2004). It is estimated that the marine fishery sector accounts for about 3.9% of Ghana's gross domestic product (GDP) and 11% of the Agriculture GDP (Bank of Ghana, 2008). The total landings from inland fisheries constitute approximately 10% of the total national landings of capture fisheries, with the remainder coming from the marine fisheries. The inland fisheries are all artisanal operating from about 1,232 fishing villages along the shores of the Volta Lake (Braithwaite, 2003).

The artisanal fishery plays an important role to coastal communities by providing employment, revenue, and a resource for food. It contributes to the national economy in terms of food security, employment, poverty reduction, GDP and foreign exchange earnings. However, the artisanal fisheries are confronted with challenges, which includes high post-harvest losses and handling costs as well as low economic returns and low value addition (Aheto et al., 2012; Mills et al., 2012; Mensah & Antwi, 2002). Artisanal fishers are dependent solely on inland and marine resources and their contribution to the national food system will require appropriate investments in developing the seafood value chain to reduce the waste, enhance efficiency, and strengthen value addition. Therefore, broadening the applicability of the existing FMIS to include the marine artisanal fisheries subsector will go a long way to improving the welfare of artisanal fishermen through a reduction in transaction costs and improvement in the benefits from fish trade.

The FMIS at this stage is a pilot technology that functions with a focus on tilapia and catfish. The services it provides help to address market information asymmetries between buyers and sellers of tilapia and catfish, and is helping to improve the bargaining power of smallholder fish farmers/fishers in their interactions with fish traders. The system is enhancing the efficiency of input use and increasing the size of the average fish by delivering concrete suggestions and market information through mobile messaging. These benefits are lacking in the marine artisanal fisheries subsector though fish from capture fisheries form part of the whole seafood value chain in Ghana. In addition, it is important to find ways that best allows the benefits of the system to reach many more stakeholders and general fish consumers.

This investigation will expand the functionality of the current FMIS with more value chain services to include prices of inputs, prices of marine species at selected landing sites, and access of the system to consumers. By providing farmers easy access to information on fingerling and feed prices and where to buy them further empowers them to farm efficiently. Allowing consumers of fish access to market prices will further close the gap between what farmers are making and what consumers are paying. The FMIS thus creates an enabling environment where stakeholders in the fish value chain are better informed. The improved system will help fish farmers/fishers, fish processors and traders to more efficiently support urban markets with seafood products. In addition, the improved FMIS will have applicability to the marine artisanal fisheries subsector from fish trade.

### **Quantifiable Anticipated Benefits**

1. A Market Information System that organizes market prices of seven major seafood species in Ghana and serves as a resource for the development of marketing plans and strategies.
2. Access to sufficient seafood market information that is needed for informed market and policy decisions.
3. Database assembled over a period of time will be available to US researchers for any quantitative analysis of the seafood market in Ghana.

4. An information system that can be expanded into a portfolio of agricultural-based and non-agricultural rural enterprises.

### **Research Design and Activity Plan**

#### ***Methods***

*Objective 1: Broaden the applicability of existing FMIS to include the marine artisanal fisheries subsector.*

The current market information system in Ghana focuses on only tilapia and catfish prices from different supply points and markets. The marine species that dominate fish catch landed are sardinellas, anchovies, mackerels, red fish, and tuna (Aheto et al., 2012; Amador et al., 2006). **Farmerline** will provide additional programming to broaden the applicability which allows marine artisanal fishermen to obtain market prices for 5 major marine and species (Tuna, Dentex [Redfish], Mackerel, Sardinellas, and Caranx) landed in the major markets via voice and SMS/text messaging. Artisanal fishermen will register with the system and can request the market information through a short code. Fisheries officers and agents will be recruited to visit selected landing sites the coastal regions of Ghana as well as major retail markets weekly to obtain prices. Preliminary discussions have taken place with the Ministry of Fisheries and Aquaculture Development (MFAD) on providing assistance through the fisheries officers. FarmerLine also has field officers who will assist with the collection of market prices. A weighted average weekly price will then be calculated and made available to users.

*Objective 2: Expand the functionality of the FMIS by customizing market price collection procedure to enable accurate and real time data collection.*

Farmerline will provide the services of additional programming to further improve the quality and timeliness of data collected through customization of the MERGDATA platform. The data collection process will be complemented with crowd-sourced information from consumers selected randomly to provide vital feedback on the validity of the prices being received. Thus, there will be new partnerships and expanded scope of engagement with information assembled in the FMIS database. The enhanced FMIS would provide more accurate and timely market information.

*Objective 3: Train artisanal fishermen on the use of the Seafood Market Information System.*

Two landing sites along the coast, one each in the Greater Accra region and Central region, will be identified as a venue for training. The training activities will be conducted in collaboration with the MFAD, chief fishermen, and elders in the selected fishing communities. The workshops will be publicized through the MFAD and by word-of-mouth in the coastal communities. Regional and District fisheries officers will be involved in the training of the artisanal fishermen.

### **Trainings and Deliverables**

1. Two training programs on how to use mobile phones to receive information on seafood prices and other market data will be offered to artisanal fishermen one each in the Greater Accra region and Central region. It is anticipated that there will be 50 participants at each of the training sessions (total of 100).
2. A database of seven major seafood prices and other market information – Tilapia, African catfish, Tuna, Dentex (Redfish), Mackerel, Sardinellas, and Caranx.
3. An electronic forum for users of FMIS that enhances seafood market activities for small-scale fish farmers, artisanal fishermen, fish retailers and consumers.

### **Beneficiaries**

Fish farmers, artisanal fishermen, fish processors, seafood traders and retailers, consumers, and policy makers.

### **Future Plans**

The plan is to get as many users as possible for the enhanced FMIS. A high patronage of the system makes a pay-per-use more feasible. Widening the scope of information and services available on the FMIS platform will expand usage by many more stakeholders that will include fish farmers, artisanal fishermen, fish processors, seafood traders and retailers, consumers, and policy makers, etc., which then allows for maximum impact through scale and sustainability. The benefits shown to stakeholders using the information will motivate stakeholders to pay, which allows for further development of the system to fit the needs of users. Charges for usage will take into account the cost of system maintenance and programming support. Pricing arrangements will be made with mobile phone companies for long-term financial sustainability of the system.

### **Schedule**

Renew / Amend subcontracts with KNUST and <i>Farmeline</i>	August – October 2016
Additional Programming of the electronic information platform	November 2016 – March 2017
Data and information collection from landing sites and market centers in the coastal regions.	April – June 2017
Field testing of the enhanced FMIS	July – August 2017
Training marine artisanal fishermen in the use of FMIS	September – December 2017
Reporting	January – February 2018

## **AFRICA PROJECT: KENYA & UGANDA**



AQUACULTURE DEVELOPMENT IN KENYA AND UGANDA: ADVANCING COST-EFFECTIVE TECHNOLOGY, MARKET ASSESSMENT, AND END-USER ENGAGEMENT

### **GENDER INCLUSIVENESS STRATEGY**

The Regional Fisheries Livelihoods Program (RFLP) (2013) recently summarized some key points for including gender in fisheries and aquaculture. Poor farmers, especially women who perform most of the agriculture (aquaculture is farming of fish) can grow fish to diversify livelihood options and increase income. Previous ACRSP research, training, and education have demonstrated the necessary pond dynamics, management practices and pond fish production with varying degree of success in Africa. They recommend:

1. Identify if policies in the fisheries and aquaculture sector are gender blind, gender neutral, or gender discriminatory.
2. Think gender during the planning/formulation phase of projects, proposals and activities. Don't let it become an afterthought. Learn to look at policies, project proposals, activities etc., through a gender lens. Assess whether gender issues have been considered and if not, try to ensure that they are. We will address this in a project paper.
3. Avoid using terms such as 'fisherman' or 'middleman'. At times it may seem unnecessary or even silly to do so, but use of these terms reinforces the image of fisheries being a male only domain when usually this is incorrect.
4. Make sure activity proposals (such as for training) clearly specify the involvement of women in terms of numbers and if possible, suitability. Think about who will be using what, when buying equipment, and do not assume tools and technology are gender neutral. All our trainings by definition are structured to be gender-balanced.

In particular, women have a notable role in the value chain for lungfish, as gatherers of wild fry and as vendors of wild stock. We will target the role of women as managers of cage-based grow out systems. We also will seek to empower women's groups as sources of fry as the nascent industry for culture of lungfish may develop. For cell phones and other technologies to benefit women in aquaculture production and to challenge existing gender imbalances in rural livelihoods, it is necessary to understand women's status and the gender roles and responsibilities in the society. It is also important to have an understanding of the multiple gender dimensions, which have an impact on accessing and using cell-phones. Rural women are less likely to prioritize mobiles in their daily lives as they have less time and less comfort in using cell-phone services (e-Agriculture, 2013). We have one activity exclusively focused on women and mobile-based services for input reconnaissance, diagnostics, and marketing.

The larger development community recognizes the importance of emphasizing equitable opportunities and benefits for both genders, a principle endorsed for the use of Information and Communication Technology (ICT) in agriculture as well. Access to and use of ICTs are often unequal, with women suffering the consequences. In a number of cases, however, ICT has been used to benefit agriculture while empowering women. If gender is missed in rural ICT initiatives then an opportunity to improve the socio-economic conditions of women, who are the largest and most active component of the rural population, is missed (World Bank, 2013). Government support and promotion of rural infrastructure and equal access to and use of ICTs among women and men is critical. Policy makers need to include a gender lens on every policy that affects access to and use of ICTs in rural communities.

## GENDER INVESTIGATION

### *Women in Uganda Aquaculture: Nutrition, Training, and Advancement (16BMA04AU)*

#### **Objectives**

1. Train women participating in the value chains of new and established culture species on marketing and nutrition, promoting the understanding of fish as a dietary asset for women and children.
2. Support events among the target populations of fish farmers focusing on women.
3. Develop capacity to access fish production, nutrition, and market information through a series of conferences, workshops, and a national symposium.

#### **Significance**

This activity outlines a capstone series of events that will engage Uganda AquaFish with institutional partners and the industry to propagate understanding of the nutritional value of a new species and enhance the status and role of women in aquaculture. It builds on the previous project by connecting the project of fish farmer cooperatives across the country, women's groups working in aquaculture, and to Nutrition Innovation Lab researchers in Uganda working on nutrition issues who can amplify and refract the scientific information about fish culture produced by the project.

Lungfish is an indigenous species in that has reproduced in activity under the aegis of previous AquaFish work led by John Walakira. The work described here endeavors to advance the role of lungfish and other fish species as food items in Ugandan diets. We seek to expand the participation of women in production, market development, and use of lungfish and other fish species through training, demonstration, and dialogue among stakeholders. New understandings about how to reproduce and grow this fish will advance farm income and household nutrition.

Poor families in developing countries typically spend between 50 to 70 percent of their income on food (IFPRI, 2015). When meat, fish, eggs, fruit, and vegetables become too expensive, families often turn to cheaper cereals and grains, which offer fewer nutrients. Widely available, affordable, and wholesome fish can have profound impacts on human development, particularly in the critical first 1000 days of life (Save the Children, 2012). Women tend to cut their food consumption first, and as a crisis deepens, other adults and eventually children cut back. Lungfish are a plentiful source of iron, a critical dietary requirement for children and potentially countering anemia, a significant problem for women.

Lentisco and Lee (2014) identified three main ways in which women access fish as a food item. First is primary access through fishing and financing/owning fishing operations; second is through close personal relationships including family; and third is through the normal purchases in local markets. Fish farming presents a fourth path for women's access to fish. Women producing fish from ponds in Uganda are members of the segment involved in fish-harvesting as primary users; secondary users are those that access fish through kinship or other relationships; and women who buy fish directly from fishers or traders are tertiary users (Lentisco and Lee, 2014).

Communication is a fundamental aspect of value chain development and mobile phones have become a central means for advancing these processes. Yet women face continuing barriers to participation. While mobile phone penetration is very high in Africa at almost 80 percent, women in sub-Saharan Africa are on average 23 percent less likely to own a mobile phone (GSMA, 2014). One critical obstacle to women's access to mobile phones is affordability: Expensive mobiles are reserved for use by men, and women tend to get second-hand phones. Technology often is viewed as a tool for men, so it seems that culture and attitudes toward ownership of productive assets can still be impediments to women's access to technology (GSMA, 2014). Trainings and conferences must address the role of cell phones in women's empowerment.

As aquaculture is often an activity that can be done close to the household, increasing the participation of women can be a strategy for empowerment, but it must be accompanied by secure rights to the resources such as farm space (Lentisco and Lee, 2015). For example, lungfish (*Protopterus aethiopicus*) is an emerging culture species in Uganda and there may be opportunities for women to participate in the development of this value chain in a fundamental way (Walakira et al., 2012).

Some of the gains of empowerment include: women's own income; membership in decision-making bodies; exercise of influence in their communities for aspects that are important for them, such as education for their children and dealing with alcoholism. Lentisco and Lee (2015) also cite gains in self-esteem and bargaining power within their households.

Some women-operated kiosks feature lungfish products (Walakira et al., 2012). In Kampala suburbs and some rural centers, women own the majority of these kiosks, selling fried lungfish chunks and boiled lungfish soup during the evening. Walakira et al., (2012) reported that a small number of restaurants have lungfish on their menu, preparing fresh, smoked and fried fish meals. Some restaurants in Kabusu and Owino centers (Kampala district) specialize in selling fried lungfish pieces.

### **Quantified Anticipated Benefits**

- A Conference on Advancing Nutrition and the Status of Women through Uganda Aquaculture will involve at least 30 participants from women's farming groups, cooperatives, women-led fish-related business, and others in the value chains of tilapia, lungfish, and clarius.
- A training on women's organizations in development will target the leadership of cooperatives and women's organizations.
- Training on value chains, mobile applications, and marketing in aquaculture, although addressed to a broader audience, this training will feature women's involvement in the value chain and women as primary providers of child nutrition in Uganda.
- The Annual Fish Farming Conference and Trade Show is an annual activity that this project will reinforce and infuse with gender-related activities to engage all participants in the ways that women can advance aquaculture in Uganda.
- Three presentations to fish farmer cooperatives will address technical needs and issues, as well as specific gender-related concerns in the operation of farmer associations.

### **Research Design and Activity Plan**

***Activity 1: Organize and conduct a conference on Advancing Nutrition and the Status of Women through Uganda Aquaculture***



We will work with Makerere University colleagues affiliated with the Nutrition Innovation Lab to plan and program this conference -- Professor Bernard Bashaasha (Nutrition Lab project PI), Dr. Turyashemererwa (Project Coordinator), and others from the Nutrition Lab. In particular, we will address the potential benefits of broader availability of lungfish as a food item in Uganda. The meeting will involve at least 30 participants from women’s farming groups, cooperatives, women-led fish-related business, fisheries students, and others in the value chains for tilapia, clarius, and lungfish. Gertrude Abalo, the Principal of the Fisheries Training Institute (FTI)<sup>1</sup> in Entebbe, Uganda will be enlisted to guide and host this conference. As an institution focused on aquaculture and fisheries with a high proportion of women in the student body, this school will benefit from leading the conference and liaising with AquaFish institutions.

The event will target the leadership of cooperatives and women’s organizations. We also foresee an anticipatory session or a pre-meeting event to the Annual Fish Farmer Symposium and Trade Show in February 2017. Presentations will provide an overview and perspective on gender issues in aquaculture and institutional participation that advance women and address gender equity in value chain engagement. We envision one focus on the development of the value chain of emerging species such as the lungfish. Training on value chains and marketing in aquaculture, although addressed to a broader audience, this training will feature women’s involvement in the value chain and women as primary producers of fish in Uganda. We envision this a cross-cutting activity on the project as marketing studies, consumer preference, cell-phone applications, and the results of new species development all bear on the topic. We envision a meeting that outlines the way forward in industry development and market expansion for Uganda fish farmers. One study summarizing women’s involvement in value chains reported that successful women entrepreneurs felt additional skills were still needed to build their competency, especially more integrated business, and leadership skills.

***Activity 2: Conduct an edition of the Annual Fish Farming Conference and Trade Show with a focus on women in aquaculture***

The Annual Fish Farming Conference and Trade Show is an activity that this project will reinforce and infuse with gender-related activities to engage all participants in the ways that women can advance aquaculture in Uganda. Women’s individual agency is crucial for development as it enhances one’s capacity to navigate the psychological, socio-cultural and structural challenges that are faced on a daily basis. It is important that efforts move beyond technical training, although that remains a fundamental, continuing unmet need, to a broader vision of fish farming as a source of nutritional security and income for Uganda families. Women’s empowerment is a potential by-product of improved access to inputs and markets, but there is also a need to move to amplify women’s roles, agency and voice in this sector. Without direct and active involvement of women the industry will not progress.

Three presentations to fish farmer cooperatives will address technical needs and issues, as well as specific gender-related concerns in the operation of farmer associations. The fish farmers outside Kampala are often overlooked by project activities.

**Trainings and Deliverables**

Item	Mechanism (e.g. podcast, reports, factsheets).
Conference on Women in Uganda Aquaculture	Fact sheet on women’s roles in Uganda aquaculture
One training on women’s organizations	Leaflet providing practical guidance to women’s groups

<sup>1</sup> Fisheries Training Institute (FTI) provides comprehensive instruction to increase fish production and improve utilization of fish and fish products. It is a Regional Institute, one of few such Institutions in Africa. The Institute sits on 9.3 hectares of land on Bugonga point, near the Entebbe airport about 2½km from the main road at Lake Victoria Hotel.

in development for women farmers and service providers	
One training on value chains and marketing in aquaculture for farmers	Leaflet providing practical guidance to women's groups with focus on nutritional value of lungfish
Presentations to fish farmer cooperative members and leaders	Fact sheet for leaders and participants in cooperatives with emphasis on lungfish as a new market item

### **Schedule**

Activity	2016		2017			
	3 <sup>rd</sup>	4 <sup>th</sup>	1 <sup>st</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>	4 <sup>th</sup>
Conference on Women in Uganda Aquaculture		x	x			
Training on value chains and marketing in aquaculture		x				
Fish farming conference and trade show			x			
Presentations to fish farmer cooperatives			x	x	x	
Report writing, workshops, journal article		x	x	x	x	x

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