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

GENDER INTEGRATION PLAN 2013-2018: VOLUME I

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AQUAFISH INNOVATION LAB

OSU Oregon State University

AQUAFISH INNOVATION LAB: GENDER INTEGRATION PLAN 2013-2018: VOLUME I

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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
Girl processing fish at Tri An Reservoir, Vietnam. Photo courtesy of Peg Herring.

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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, 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.

> "*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

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 education, technology, ability to access loans, retain autonomy over earnings, or own land (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*, 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

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. 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.

A women's aquaculture cooperative in Chitwan, Nepal. Photo courtesy of Stephanie Ichien.

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.

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

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

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 new 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, 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 (see http://aquafishcrsp.oregonstate.edu/Gender/).

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. As described in #4 above, 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			
		2007-2013 Actual	2014 Target	2015 Target
	Total	352	44	44
	Female	168	22	22
	Male	184	22	22
4.5.2(7)	Number of individuals who have received US government supported short-term agricultural sector productivity or food security training			
		2007-2013 Actual	2014 Target	2015 Target
	Total	5,852	600	600
	Female	2,005	300	300
	Male	3,847	300	300

AQUAFISH PROJECT 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. 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. Gender integration is a crosscutting theme and is considered in every AquaFish investigation. Additionally, as required in the AquaFish 2013-2015 RFP, each project has the following activity specifically focused on outreach to women:

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, Hajee Mohammed Danesh Science and Technology University, Khulna University, University of Dhaka, Shushilan NGO, Central Luzon State University, South East Asian Fisheries Development Center, and WorldFish
Gender Investigation: *Improving Nutritional Status and Livelihood for Marginalized Women Households in Southwest Bangladesh through Aquaculture and Value Chain Analysis*

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 at Avery Point (Lead US University), University of Rhode Island, Inland Fisheries Research and Development Institute, and Can Tho University
Gender Investigation: *Enhancing Food Security and Household Nutrition Vulnerability of Women and Children with a Focus on Nutrient Dense Commonly Consumed Fish from Capture Fish and Aquaculture in Cambodia*

Asia Project: Nepal | Development of More Efficient and Environmentally Sustainable Aquaculture Systems for Nepal
Project Partners: University of Michigan (Lead US University), Agricultural and Forestry University, Nepal Agricultural Research Center, and Directorate of Fisheries Development
Gender Investigation: *Establishing School Ponds for Fish Farming and Education to Improve Health and Nutrition of Women and Children in Rural Nepal*

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, FarmerLine, University of Development Studies, Tamale, Kwame Nkrumah University of Science and Technology, Ministry of Agriculture, Livestock, and Fisheries, Sokoine University of Agriculture, Western Indian Ocean Marine Sciences Association, and University of Dar es Salaam
Gender Investigation: *Spat Collection and Nursery Methods for Shellfish Culture by Women*

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, University of Eldoret, KMFD Sagana, Makerere University, and National Fisheries Resources Research Institute (NaFIRRI)
Gender Investigation: *Approaches to Inform, Motivate, and Advance Small and Medium-scale Fish Farmers: Building Industry Capacity Through Cell Phone Networks, Training, and Market Participation*

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

ASIA PROJECT: BANGLADESH

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

GENDER INCLUSIVENESS STRATEGY

This project utilizes three female host-country investigators, who help set priorities and will be key to implementing project activities at Bangladesh Agricultural University (BAU). Several of the graduate and undergraduate students who will be working on these projects are also female. We will consider gender in all activities conducted within the host country as well as in the United States. One of the PIs, Dr. Emilia Quinitio, is the Head of the Technology Verification and Demonstration Division at the Southeast Asian Fisheries Development Center (SEAFDEC), and is a world-renowned specialist on shellfish culture. We firmly believe that female role models are crucial for attracting women into the fields of scientific research and outreach, and in empowering them to promote sustainable farming activities. We continue to commit considerable effort in incorporating women into our activities, with high priority on the participation of women within host country institutes. Dr. Quinitio will provide training on best production practices to approximately100 women culturists who solely rely on crab fattening for their economic livelihoods. We will also work with women in undertaking feed trials for on-farm fish polyculture and gher/prawn crop integration trials. A prominent role of women in farming households is to feed fish and maintain crops for household consumption. We will also be assessing women on household consumption of vegetables and nutrient-dense fishes as part of our program to integrate 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. Collectively, we anticipate that 200-300 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 Project PI, Dr. Russell Borski, is actively involved in both the Women in Science and Engineering and the Wolfpack Women in Science Organization programs at North Carolina State University, organizations dedicated to promoting the number of women entering science programs and choosing science-related fields as a professional career choice. Dr. Borski currently mentors both 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 25 students involved in these projects will be female.

GENDER INVESTIGATION

Improving Nutritional Status and Livelihood for Marginalized Women Households in Southwest Bangladesh through Aquaculture and Value Chain Analysis (13MER04NC)

Objectives

The focus of this investigation is to better identify the role aquaculture species play in the lives of impoverished women culturists in Southwest Bangladesh, with specific focus on the nutritional and economic benefits (both potential and actual) derived from these endeavors. Through value-chain analysis, in concert with training on best management practices, we expect to generate improvements in household nutrition and economic profitability for the benefit of impoverished women in coastal Bangladesh. Specific objectives include:

1. Determine present status of household nutrition through surveys to understand the contribution of cultured fish species to the nutrition of women-led households.
2. Disseminate better management practices, including the integration of tilapia, to facilitate both greater availability of fish for household consumption, and environmental sustainability for the current farming practice of mud crab fattening/culture.
3. Study the value chain of tilapia and mud crab culture to firmly establish the role of women within multiple segments of the value chain to enhance their empowerment, incomes, and livelihoods.
4. Formulate policy recommendations to improve the nutritional status and livelihoods of marginalized women-led households in the Southwest region of Bangladesh through integrated and diversified aquaculture practices and an improved value chain.

Significance

Coastal (southwest) Bangladesh is highly vulnerable to the impacts of global climate change, and due to extreme poverty and malnutrition, is an important target area for the USAID "Feed the Future" Initiative. Within coastal Bangladesh, three districts (Satkhira, Khulna, and Bagerhat) that surround the Sundarban mangrove forest are considered the most threatened, suffering repeatedly from the effects of calamitous storms (e.g., cyclone Sidr, 2007; Aila, 2009). During periods of high flooding, the average consumption of staple rice falls to 33% of the minimum nutritional requirement, resulting in acute malnutrition and chronic energy deficiency, particularly in women and children (World Food Program, 2011). While men in this region commonly engage in day labor or have migrated to urban areas to obtain low-income work, the majority of women in this population rely directly on subsistence farming of natural wetland resources. The prevalence of impoverished women-led farming households in coastal Bangladesh, traditionally underrepresented in the economic market chain, make this demographic particularly susceptible to exploitation and thus a key target for improving dietary nutrition and earned incomes of the impoverished Southwest. As fish commonly contribute 63% of dietary animal protein intake for Bangladeshis (Belton et al., 2011), this investigation will focus on two key aquaculture species, tilapia (*Oreochromis* spp.) and the mud crab (*Scylla serrata*), the latter primarily cultured alone, but may be integrated with tilapia. We anticipate that integrative culture of these species can significantly improve the nutritional and economic well-being of female-led households as well as the environmental impact associated with crab-fattening where feed inputs are significant and water exchanges are common, leading to excessive inputs to the environment. A key component of this study will be to promote the culture of *both* species by women to foster better food security through diversification of dietary resources. A secondary benefit of this strategy is that tilapia can also be used as feeds for mud crab fattening, which are traditionally reliant on fisheries by-catch. The co-production of both species, combined with ongoing research into crab hatchery development (through activities at WorldFish in Dhaka, Bangladesh) will go a long way towards securing an environmentally sustainable industry and promote better food security for impoverished women aquaculturists in coastal Bangladesh.

The culturing or fattening of mud crab (*Scylla serrata*) is an emerging industry (Azam et al., 1998; Khan et al., 1991) directly benefiting women-led households in coastal Bangladesh. The large-clawed mud crabs are high commodity seafood items due to their delicacy, medicinal value, and demand in international markets (Ali et al., 2004; Keenan et al., 1997). Of the 2,428 crab farms in the severely impacted regions (Satkhira, Khulna, and Bagerhat), 37.8% are currently owned and operated by women (26-41% by region; Shushilan unpublished report). Even farms not directly owned by women commonly rely on this demographic for stock collection of juveniles from shrimp ponds or other wetlands. Currently, very little information has been collected or published about these endeavors, yet while women aqua-farmers likely obtain economic benefits from crab fattening, this is solely marketed as an export crop, thus may not directly benefit the dietary needs of women and children. Given a poorly defined value chain, where the roles and participation of women may be underestimated or under-appreciated by local government agencies, little protection from exploitation (by intermediary market buyers) currently exists. Through greater investigation of the mud crab value chain in the lives of women aquaculturists, this study will identify key opportunities and constraints for this industry, for which women play important roles.

To more directly improve the dietary nutrition of women and children, and create a sustainable method of mud crab fattening, our objective is to promote integration of seawater-tolerant tilapia (*Oreochromis mossambicus*) into traditional mud crab culture, thus providing greater crop diversification. The live mud crab industry holds promise for improving economic opportunities in regions sensitive to global climate change (e.g., seawater incursion, storms), with current annual production estimates at 10-15,000 mt (Zafar and Siddique, 2000). Despite economic benefits, the dietary conditions for many women-led households in these regions are extremely poor, and may constitute only staple rice, supplemented periodically with local vegetables and fish (S. Biswas, pers. comm., 2013). As tilapia farming continues to grow in Bangladesh (Ahmed, 2007), including in the Southwest region (Hussein, 2009), the integration of tilapia into mud crab culture may enhance the incomes of women-led households through sales in domestic markets, and improve their food security by direct household consumption. The growing number of Bangladesh tilapia hatcheries and the availability of seed stock readily allow for integration of tilapia into traditional mud crab farming. As tilapia is commonly grown worldwide, its value chain nonetheless varies widely, depending on local culture practices and market conditions. We will evaluate the tilapia value-chain in conjunction with that of mud crab to facilitate the development of both industries and their potential integration within the Southwest.

The farming of tilapia can also substantially improve the environmental footprint of mud crab farming. Recent investigations by the ProsCAB project (Anon, 2008) found that traditional fattening practices suffer from over-reliance on fisheries bycatch for crab feeds, and poor water quality in the holding ponds and receiving waters, which result in harmful algal growth. This study will address these problems by testing whether excess tilapia juveniles, reared in the crab ponds, can be used as feeds for the crabs, thus reducing the reliance on fisheries bycatch. Through extensive training of women farmers in the best management practices of tilapia-mud crab farming, we anticipate improvements in environmental water quality, through better knowledge and utilization of feed/fertilization inputs. As the tilapia will feed solely on pond primary productivity, otherwise harmful nutrients will be utilized by the system in our stratified design.

This study is designed to foster greater participation of women in aquaculture in the impoverished coastal regions of Bangladesh, achieved through a better understanding of their role in the economic value chain. Through integrative polyculture of tilapia with mud crab fattening, these investigations promote better food security and dietary nutrition for women-led households through greater crop diversification and training in best management practices for tilapia-mud crab culture. Currently, the production systems for mud crab fattening are less advanced relative to other aquaculture sectors (Begum et al., 2009). This investigation will provide on-site training along with current research into mud crab farming (e.g., captive breeding of seedstock, water quality, cage culture) to achieve sustainable development for this industry.

Quantified Anticipated Benefits

The completion of nutritional and value chain analyses for tilapia and mud crab culture, examining the role and benefit derived by the women aquaculturists, will allow policy makers and NGOs to intervene in the production and value chain where necessary to directly improve household nutrition and earned income for impoverished women to better protect this demographic. More specifically, these anticipated benefits may include:

1. The ability of women involved in aquaculture to reap employment, nutrition, and income benefits from aquaculture will increase.
2. Bangladeshi women producers in Southwest region will diversify their dietary nutrition and income opportunities through integrated tilapia-mud crab pond culture.
3. Improvements in market and processing activities will provide additional employment opportunities with expanded roles for women in these tasks.
4. Practical training and information regarding best management practices will improve existing practices for mud crab fattening in these regions, as well as the new integrated tilapia-mud crab design (100 participants).
5. Greater adoption and inclusion by women in aquaculture will provide greater opportunities for mitigating the negative nutritional and economic effects of global climate change for coastal Bangladesh.

Plan of Work

Location

These studies will be conducted in the Khulna, Satkhira, and Bagerhat districts of Southwest Bangladesh, with on-site interviews conducted by W. Jamandre, U. Hatch, S. Biswas, S. Haque, and A. Torab. The workshop and on-site extension training will be conducted by E. Quinitio, S. Biswas, and other local experts.

Methods

1. Determine the present status of household dietary nutrition through surveys to assess the contribution of seafoods, including mud crab and tilapia, in women-led households.

Household nutrition surveys will be conducted within the study area by Dr. A. Torab Rahim and S. Biswas. These surveys will focus on food consumption, and how low-intensity culture species (including mud crab and tilapia) and other seafoods contribute to the dietary nutrition and earned incomes (both actual and potential) of surveyed families. A baseline survey will first be conducted by pre-tested questionnaire before the intervention program (see Study 2), utilizing both qualitative and quantitative methods of data collection (Swindale and Belinsky, 2006). Household demographic and socio-economic information will be collected through collaborative participation with local NGO partners, government representatives, or other relevant stakeholders. The sample size for these surveys will be determined according to FANTA III sampling guide (Magnani, 1999; 2012 addendum). This value will be increased by 10% to account for potential non-responses (N = ~200 individuals). A second survey will be performed on a subset of those families that participated in the baseline survey and who undertook pilot studies on integrative tilapia-mud crab culture (Study 2A) to determine if income and tilapia consumption increased within the household. During the program, a subset of targeted households containing women aquaculturists will be followed, with each member of the household identified (average 4 per household, including children < 5 years of age, or females of adolescent age or younger) being tracked. Statistical analyses, including household dietary diversity scores, will be performed using SPSS following the tabulation, classification, and coding of collected household data (Magnani, 1999; Swindale and Belinsky, 2006).

2. Disseminate better management practices for integrated tilapia-mud crab culture to facilitate food security and economic well being of women-led households.

2A: Integrated tilapia-mud crab culture practices: This pilot study will demonstrate the potential benefits of integrated tilapia and mud crab culture to practicing women aquaculturists who utilize mud crab-fattening as a source of income. The benefits of integrating tilapia into mud crab fattening will be shown by the following: 1) greater supply of nutritious foods for household consumption, 2) improved earnings by the sale of extra tilapia in domestic markets, 3) improved environmental water quality resulting in less stock mortality and environmental impacts, and 4) a decrease in the reliance of fisheries bycatch for use as crab feeds. The latter benefit, utilized through feeding of extra juvenile tilapia to crabs, will also improve the environmental sustainability of this industry. The design is as follows:

Participating members from women-owned farms or from women-led households will be included within the sample set identified in Study 1 (N = 45 ponds, ~180 household members). Sites will be selected to have a salinity range (5-25 ppt) tolerant for tilapia (*O. mossambicus*) breeding and mud crab fattening (Popma and Masser, 1999; Shelly and Lovatelli, 2011). If possible, an equal number of ponds from all three districts (Khulna, Satkhira, and Bagerhat, 15 per district) will be used. Ponds will be randomly assigned to 1 of 3 treatment groups (N = 45; n = 15): (1) control – only traditional mud crab fattening practiced, (2) integrated tilapia-mud crab farming where the tilapia are sold to market, and (3) tilapia-mud crab farming where the tilapia are directly consumed by the household. In the tilapia groups, small juveniles (~10g, produced by tilapia breeding within the ponds) will be harvested weekly for use as supplemental crab feeds. Treatments 2 and 3 will be stocked with mixed-sex tilapia of breeding size (3 female: 1 male) at a density of 1 fish/m^2. The study will be conducted over a single tilapia production phase (2 crab fattening cycles). Mud crabs will be stocked at an equivalent, standardized density (2-3/m^2) for all ponds. The tilapia will be raised only on pond primary productivity derived from excess crab feeds, and fertilized (28 kg N, 7 kg P/ha) only if productivity is low (> 40 cm Secchi disk depth). Water quality will be monitored weekly by Secchi disk readings in all ponds, with further chemical analysis (total nitrates, phosphates, dissolved oxygen) tested at bi-weekly intervals for a subset of each treatment group (n = 3; N=12), which will be analyzed at the Water Quality and Pond Dynamics Laboratory at BAU. All participating households will be given a data collection notebook to record crab feedings, yields of tilapia (kg) harvested, proceeds from crab and tilapia sales (yield, kg; market returns), and input costs associated with crab feeding. Evaluation of nutritional benefits derived from direct consumption of tilapia will be examined as part of Study 1. Crop production (tilapia and mud crab) yields, estimated market returns, environmental water quality, and input costs between treatments will be evaluated by Analysis of Variance using SPSS.

Null hypothesis: There is no difference in total pond production yield, feed input costs, household nutrition, environmental water quality, or economic return when tilapia are integrated with the existing practice of mud crab fattening.

2B: On-site training workshop: In Bangladesh, aqua farmers have been practicing mud crab fattening mainly in earthen ponds; however, escape through burrowing is a common problem. High mortality and poor survival are the main production constraints. Introduction of cage culture and other innovative enclosures is new in Bangladesh though alternatives have been adopted in many Southeast Asian countries, e.g., bamboo (DA, Region VI, 1988) and net cages (Kuntiyo, 1992) in the Philippines, bamboo enclosure and cage in river and canals in Myanmar (Felix et al., 1995), and floating cage culture in Vietnam and Malaysia (Sivasubramain and Angel, 1992). Dr. Quinitio (Co-PI) will evaluate current mud crab fattening and culture practices and conduct a training workshop on best management practices in the 2nd year of the project. The progress of Study 2A will be assessed and an additional on-site training workshop for women aquaculturists will be conducted in the 3rd project year. This workshop will be designed to help women aquaculturists improve their farm practices including potential integration of

tilapia. An analysis of the best management practices for tilapia and mud crab farming will be presented with suggestions for future improvements based on research gleaned from other Southeastern Asian countries with similar environmental conditions and culture practices. Site identification and logistical support for the training and on-site workshops will be undertaken by S. Biswas (Shushilan NGO), and focus on a diverse range of topics regarding current and future practices of the industry (e.g., culture systems, integrative aquaculture, and hatchery/nursery technologies, aqua-silviculture). Additional topics will include current shortages and high feed prices associated with reduced by-catch, the value of tilapia as a crab feed alternative, and the need for integrative polyculture to address nutritional needs for regions severely impacted by global climate change.

3. Value chain analysis for tilapia and mud crab to establish the role of women, in different segments of the value chain, to promote their empowerment, income and livelihood status.

A secondary data series for value chain analysis of tilapia and mud crab (Jamandre and Hatch) will be obtained from Bangladeshi government agencies, academic universities, WorldFish, and NGOs. Previous studies on production/marketing and women's role in aquaculture will also serve as a source of documenting information. The results of the nutritional survey along with data collected from Shushilan NGO (S. Biswas) will be used for targeting the value chain analysis as well as provide recommendations toward improving the socioeconomic and nutritional well being of disadvantaged women. The analysis will employ institutional economics concepts to identify and focus where governance, structure, and efficiency can be improved for the benefit of impoverished coastal women. It requires evaluation of the value chain map (transaction costs, processes, power structures) and identification of intervention areas (Cooper et al., 1997). The following primary data will be collected: key players and their respective roles, activities, and services provided; supply chain product requirements (especially quality standards); information and money flows; critical logistics issues (including problems in production and marketing); extension services; and external influences (Williamson, 1979). The existing production/marketing system imposes constraints on the opportunity for women fully benefiting from their participation in aquaculture (Ferdoushi and Xiang-Guo, 2010). This analysis will focus on improved understanding of the local, regional and national supply/value chain (Ramasamy, 2007) and the ability of local women producers to benefit from production for and marketing to consumers outside the local area. Value chain maps will be developed for each market level and performance will be evaluated for efficiency, flexibility and overall responsiveness. A similar methodology was employed in previous CRSP work for the Phillipines (tilapia farming; Jamandre and Hatch, 2010). Relevant studies (Ferdoushi and Xiang-Guo, 2010; Zafar and Ahsan, 2006) will be used to provide essential background for understanding the role of women in aquaculture production and marketing systems and for further corrective recommendations.

4. Formulate policy recommendations to improve the nutritional status and economic livelihoods of marginalized women-led households.

The nutritional and value-chain analyses will be used to generate recommendations for improving the production practices and marketing systems of cultured species to greater assist impoverished women-led households. Current best management practices, with particular emphasis on the role of women in the economic value chain will form the basis for these recommendations, along with other research conducted under similar conditions in other countries of Southeast Asia. Improved value chain analysis and understanding will lead to greater ability for women culturists to participate in the local, national and international value chain. Specific policy recommendations will be formulated to target increased nutrition and well being of women through improved tilapia-crab integrated culture and value chain promotion.

Schedule
Oct 2013 - Mar 2014: Initial nutrition survey on seafood consumption (Study 1). Dr. Quinitio will evaluate current practices and conduct an initial training workshop (Study 2B) to provide an overview of better management practices. The collection of secondary data, interviews with government and academic experts as well as marketing sector participants will be done for value chain analyses.

March - Dec 2014: Tilapia-mud crab integrated aquaculture demonstrations (Study 2A), with assessments of household consumption and income (Study 1). Preliminary value chain analysis (Study 3) completed and identification of additional data and information needed for collection during follow-up in country travel.

Jan - Mar 2015: In-country travel for data collection and interviews as needed to complete value chain analysis. On-site training workshops conducted by E. Quinitio and other team members (Study 2B).

Mar - Sept 2015: Analyses and final report.

Deliverables
1) The contribution of seafoods or lack thereof to the diets of women (and their children) whose primary livelihood is aquaculture will be described with over 200 individuals surveyed.

2) The ability of women involved in aquaculture to reap the employment, nutrition, and income benefits will increase through an understanding of the tilapia and mudcrab value chain (60 individuals interviewed).

3) The nutrition and economic benefits of 45 women-led households in 3 districts of the coastal Southwest will directly benefit through on-farm demonstration trials of integrated tilapia-mudcrab fattening culture. We anticipate significant improvements in fish consumption, earned income, water quality, and reduced reliance of fisheries bycatch when tilapia farming is integrated with mud crab.

4) Two workshops, including on-site training will provide practical information to assist women in adopting improved culture practices (100 participants).

5) Two graduate students will obtain training on value-chain analyses, nutritional survey development and analyses, and on integrated tilapia-mud crab culture.

Documentation & Dissemination
The research outlined in this investigation will be reported through the Technical Reports of the AquaFish Innovation Lab and in the theses work of participating students. We anticipate final publication of these results, if successful, within the peer-reviewed literature (1-2 papers).

ASIA PROJECT: CAMBODIA & VIETNAM

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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.

GENDER INVESTIGATION

Enhancing Food Security and Household Nutrition Vulnerability of Women and Children with a Focus on Nutrient Dense Commonly Consumed Fish from Capture Fish and Aquaculture in Cambodia
(13HHI102UC)

Objective
The objective of this investigation is to enhance the food and nutrition security of women and children through nutrient dense, commonly consumed fish and other aquatic animals (OAAs).

Significance
Population growth, and other changing variables such as rainfall, sedimentation, salinity, and human activities are said to affect fish production, livelihood opportunities, food security, nutrition, and health implications.

The fish and aquatic animals (frog, crabs, snails, and shrimp) comprise the second largest staple foods for Cambodian people, contributing about 75 percent of animal protein intake. They have formed an integral part of the diet of many rural Cambodians. Poorer households in particular, with little alternative food production capacity, turn to such sources not only for additional food for themselves to serve as nutritional food security, but also for sale to earn income. It is reported that these foods have high nutrient content and high bioavailability of micronutrients, particularly small indigenous fish species.

The application of traditional food processing/preservation technologies in Cambodia dates back to ancient times and these techniques are often used, especially in regards to fish (fermented, salted, and smoked fish, 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 becomes more restricted to fish. Trade and market impacts in production levels are said to be changed throughout the value chain such as reduced trade volume and values, reduced export earnings, reduced livelihood opportunities, and increased malnutrition.

The prevalence of malnutrition among preschool children continues to be a major problem in Cambodia. According to The National Health Statistics of Cambodia 2000, 23% of babies were born with a low birth weight (<2500g). The CDHS survey also found that 21% of mothers had a BMI below the cut-off of 18.5, indicating chronic energy deficiency. The CDHS 2000 indicated a high level of protein/energy malnutrition among children under five years of age, with a stunting prevalence rate of 44.3% (severe

stunting -3SD, 20.2%). The prevalence of wasting was 15.0% (severe wasting -3SD, 3.8%) and the prevalence of underweight was 45.3% (severe underweight -3SD, 12.5%).

The CDHS 2000 showed an overall 63% rate of anemia among children of 6-59 months. Children under two years were more likely to be anemic than older children. A high prevalence of anemia (90%) was found in the age group 10-11 months, an indication of poor complementary feeding practices. In addition, 58% of non-pregnant women and 66% of pregnant women were classified as anemic.

The First National Goiter Survey was completed in 1997 and estimated a national total goiter rate of about 12% in the 8-12 age group, with a rate of 45% in some areas. The survey recorded a total goiter rate of 17% in a sample of over 35,000 children. Results from the Cambodia National Micronutrient Survey 2000 show that vitamin A deficiency is still a problem of public health significance. The prevalence of night blindness among children aged 18-59 months was above the WHO cut-off (1%) in seven of the 10 provinces included in the survey, as well as among the lactating mothers (range: 1.1-6.8% in the 10 provinces) and during the mother's most recent pregnancy (range: 2.0-9.3%). The survey also showed that vitamin A intake was very low, with less than 10% of women and children meeting their recommended daily intake.

There is a lack of documentation on the commonly consumed traditional food items, traditional food processing technologies, and information on nutrient contents of these food groups. At the same time, the needs for improve product quality, hygiene, sanitation, the appropriate technologies, value change, and trade are also crucial.

Quantified Anticipated Benefits

- Two Master students will be involved in this investigation. They will be involved in assisting the project preparation, survey design, data encoding, data analysis, and report writing.

- At least 10 IFReDI staff will be involved in survey such as data collection and training activities.

- At least 500 IFReDI/FiA staff, scientists, researchers, government officers and managers, and NGOs in Cambodia will participate in a series of consultation meetings and workshops on the impacts of mainstream dams on the Mekong River system and climate change on fish yields for snakehead and small-sized fish, and the impacts of changes in fish yield on fish consumption and food security in Cambodia, especially by women and children and in proposing the recommended adaption options and strategies for women.

- At least 300 women in fisheries and aquaculture households in Cambodia will be better informed and have better information on current and potential impacts of climate and non-climate drivers of change on aquaculture and fisheries and corresponding adaptation strategies.

- Many others in the Mekong region will benefit from this project through sharing of research findings.

- This investigation will provide a return benefit to the US by allowing the Lead PI to expand his work in SE Asia on food security and fisheries and aquaculture and return this knowledge and information to graduate students at the University of Connecticut.

Research Design & Activity Plan

The following activities are proposed to implement this study in order to achieve the above objectives:

Activity 1.

- To identify commonly consumed-fish and other aquatic resources, aquaculture, and their products in Cambodia.
- The study will employ both primary and secondary data gathering. Primary data will be obtained through field surveys by conducting key informant interviews (KIIs), and focus group discussions (FGD). Secondary data will be obtained from journals, reports, books, and other materials collected from relevant offices, NGOs, and websites.
- Information about fish species and other aquatic animals (OAAs) will be collected based on availability, utilization, and perception of people. KIIs will be conducted with sellers, middle vendors, the elderly, hunters, and farmers from the different ecological zones in Cambodia. Locations include: Stung Treng in the upper portion of the Greater Mekong Basin; Siem Reap/KampongThom, located in Tonle Sap Lake; and Prey Veng located in the Lower Mekong Basin.

Sample size

The total number of respondents was determined based on Slovin's equation as shown below:

$$n = \frac{N}{1 + Ne^2}$$

Where n = a sample size
N = total population size from three villages
e = allowable error of ten percent (10%).

Questionnaires

Questionnaires will be formulated prior to the start of the fieldwork. The interviewers will undergo training on survey questionnaires. Each enumerator will be given a bag, notebook, pencils, etc. Training will be conducted by PIs.

Pilot Testing

Pilot testing of the questionnaires will be done in one selected commune for two to three days at suitable sites, which will be sent to the village head informing him of the conduct of the survey. A face-to-face interview with the head of the family/the household members will be done. Relevant or additional information that will be gathered should be written immediately on the questionnaire. At the end of the interview, questionnaires will be cross-checked by members of the survey team for any missing record or information. The final draft of the questionnaires will be thoroughly discussed to ensure the same understanding of the questionnaires. This will be immediately followed by database entry.

Survey

Letters to the village authorities informing them of the survey will be sent at least 1 week prior to the actual survey. The surveys will be conducted as face-to-face interviews with the formulated questionnaire and focus group discussion.

Activity 2.

- To determine the nutritional composition of nutrient dense identified commonly consumed-fish and other aquatic resources by women and children with focus on key micronutrients such as iron, zinc, vitamin A and macronutrients (protein and fat).
- Samples of selected commonly consumed fish species and OAAs will be collected fresh from landing sites, local markets, fishermen, and farmers for nutrient analyses. Subsamples of raw,

cleaned parts will be obtained by having village women clean the fish according to their traditional practices.

- Vitamin A compounds (all transretinol, 13-cis retinol, all-trans 3,4-dehydroretinol, 13-cis 3,4-dehydroretinol, and b-carotene) in fish samples will be analyzed using high-performance liquid chromatography. Calcium, iron, and zinc will be determined by atomic absorption spectrometry. The content of nonheme iron will be determined by the widely used ferrozine colorometric method. Heme iron and complex-bound non-heme iron will be calculated as the difference between total iron and inorganic iron.
- The analysis will be conducted at Mahidol University in Thailand, the National Council for Nutrition in Vietnam, or in the United States.

Activity 3.

- Analysis of recommend policy strategy for women and children.
- A series of consultations and final workshop will be conducted based on both outputs.
- Activities 1 and 2 will link up with the recommended adaption option and strategies for women and children.
- The appropriate communication products will be developed:
  - Investigation finding report in English.
  - PDF file of Investigation finding report in English which can be accessed through the web.
  - 1500 factsheets of investigation report in English and Khmer.
- Undertake activities to disseminate the communication products and promote the uptake of the study findings (e.g. meetings, workshops, mail communication products, etc.).

Location of work

Inland Fisheries and Development Institute (IFReDI), Phnom Penh, Cambodia. The field activities will be undertaken in Upstream Mekong (Sambor, Kratie Province), Downstream Mekong (PoeumRour, Prey Veng province), and the Tonle Sap area (Kampong Kreang, Siem Reap and Phat Sandy, Kampong Thom province).

Methods

The project activities are organized using a systematic, stepwise approach from collection of information on utilized foods to rigorous testing of nutrient bioavailability and efficiency, followed by promotion and dissemination of the results and development of generic recommendation policies. The activities are conducted by a multi-disciplinary research team using appropriate quantitative and qualitative research methods.

Deliverables

- Investigation finding report in English which can be accessed through the Web
- 1500 factsheets based on the investigation report in English and Khmer

ASIA PROJECT: NEPAL

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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 INVESTIGATION

Establishing School Ponds for Fish Farming and Education to Improve Health and Nutrition of Women and Children in Rural Nepal (13HHI04UM)

Objectives

- To establish school ponds in villages for fish farming and education of teachers and school-age children on the value of household ponds; and
- To develop women's fish farming groups at each school village to teach them about fish farming and household nutrition.

Significance

Women play an integral role in the aquaculture and fisheries sectors all over the world. Even though 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 that women face in aquaculture and fisheries are: time, 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 getting ahead (FAO, 1998).

Nepal has diverse agro-climatic and socio-economic characteristics but suffers from limited communication and transportation networks. Rural poverty is a key factor affecting food security. Undernutrition places children at an increased risk of morbidity and mortality and is also associated with impaired mental development. A report from the Nepal Demographic Health Survey found that 41% of Nepali children less than five are chronically malnourished and 11% are wasted (NDHS, 2011). This has declined slightly from 49% stunted and 13% wasted in 2006. Similarly, underweight children less than the age of five decreased from 39% to 29% from 2006 to 2011 (CBS, 2011).

Sadly, 85% of deaths among children less than five occur during the first year of life, and the overall infant mortality rate is 46 deaths per 1,000 live births. During infancy, the risk of neonatal deaths and post-neonatal deaths is 33 and 13 deaths per 1,000 live births, respectively (NDHS, 2011). These deaths are mostly attributed to diarrheal diseases, which can be exacerbated by undernutrition.

There is a global concern that nutritious food must be supplied to women as well as their children during the first 1000 days of life. Fish provides valuable nutrients to the world's population, including high-quality proteins (about 6% of world protein supply in 2002); balanced amino acids; vitamins A, D, and B12; iodine and selenium; and long chain omega-3 polyunsaturated fatty acids. Fish bones, when eaten, are also an excellent source of calcium, phosphorus, and fluorides (Jha, 2011; Jha and Jha, 2012).

Anemia has been a major problem in Nepal, especially among young children and pregnant women. It is prevalent mostly in rural areas, where nearly 47% of children and 36% of women have some degree of anemia. Overall, there has been very little improvement in the anemia status of children and women in Nepal since 2006 (USAID, 2011). The addition of animal source foods, such as fish rich in vitamin A, to complement the typical Nepali diet should help stem the increase of anemia (Helen Keller Institute, 2002).

Most Nepalese live in rural areas at subsistence or near subsistence levels. 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 proteins unless taken with other protein sources. An additional concern is that, people in Terai eat mainly rice, while those in the hills consume mainly corn. This tends to make their diets unbalanced in nutritional content, but it may be made nutritionally superior by supplementing the diet with fish.

For optimum human health, about 33% of total protein consumed should come from animal sources (AIT, 1994), but only 10% is from this source for the average person in Nepal. At least a three-fold increase in animal protein supply is required for optimum health of many rural people. Nepal should promote small-scale aquaculture by setting immediate and long-term objectives. The immediate need is to increase awareness among rural communities of the potential for backyard fish farming, while in the long term, commercial aquaculture should be encouraged (Bhujel, 2012).

Aquaculture is a relatively new farming activity in Nepal, although a number of ethnic minority communities have traditionally made their living from capture fisheries. Integration of pond aquaculture into the existing crop- and livestock-based farming system should be effective in increasing the local fish supply and diversifying livelihood options for small-scale farmers in the Terai and mid-hill valleys, thereby increasing the resilience of their livelihood (Shrestha et al., 2012). Increasing food and nutrition security, augmenting income, and utilization of family labor are major issues of the rural poor. Small-scale aquaculture has improved household food and nutrition security, income generation, and empowerment of women and marginalized communities. Fish has been considered "living cash" and a pond a "savings bank" because fish can usually be harvested throughout the year when needs arise (Bhujel et al., 2008; Shrestha, 2012). In a recent study carried out by University of Michigan student, Zachary Stepan, on nutrition and fish consumption among household fish farmers in the Chitwan and Nawalparasi districts, fish consumption was seasonal (due to cultural practice and beliefs) and that increased income was better correlated with improvements in nutrition rather than was fish consumption (Stepan 2013). Based on these results, educational efforts will focus on timing of fish harvests, post-harvest practices, and other income generating activities for household farmers.

We propose to use school farms 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 (Poudel et al., 2011). Therefore, training must consider these limitations while still providing for information exchange (Kloblen, 2011). Schools remain the center for learning in the community.

Having ponds in schools will help disseminate a practical, hands-on message to the local population that fish are an important constituent to boost nutrition, and hence, residents will be encouraged to build a fish pond of their own. We have already developed methods for construction and management of small household ponds, which can be extended to interested members of these communities. School pond development will also help in capacity building of teachers who could spread knowledge on importance of fish in nutrition to parents during teacher-parent interactions; additionally, small-scale fish farming techniques and their connection to income generation and increased nutrition choices can be taught to future students and parents not presently enrolled or involved in the school. It will also educate students and adults on issues of environmental sustainability and nutrition. Finally, profit from the sale of some fish will aid poor schools in developing infrastructure and covering daily expenses; part of this income associated with sales will go to long-term pond maintenance.

We plan to develop four women's fish farming groups, one associated with each school to further extend fish farming information to local women. Women's groups will not be trained at the schools, instead they will be mothers of school students and neighbors. Women groups will be formed by this project or used if they already exist from the District Agriculture Development office. Topics of instruction include fish culture and household nutrition. Since many of these women are illiterate, it will be necessary to develop special messages with clear visual and practical solutions to information exchange. The school ponds and practical training students receive will be particularly effective in this information exchange to women groups. The impact of these groups will be measured by the number of women who participate.

The long term sustainability of this project will be strengthened by involvement of AFU faculty members that have a goal of such training and outreach to the public. Initial funding of the costs of pond construction and materials will be covered by this project, and we assume the ponds will bring income and support to the schools involved and so the system will be maintained in participating schools In the future, training will be needed, as well as some labor and funding, to expand the program to additional schools. We plan to use AquaFish funds, as well as approach government labs and NGOs, to provide this future funding.

Quantified Anticipated Benefits

The development of school ponds and women's fish farming groups will increase awareness of the value of nutrition and fish consumption in rural households by teaching school-age children and adult women about aquaculture. It will help generate income for schools having ponds. It will also help in capacity building of teachers who could spread the knowledge on the importance of fish in nutrition to parents during teacher-parent interactions, now and in the future. We anticipate that at least 4 school ponds will be built, 40 or more students will be educated on the methods of fish farming, and 20 women will become educated about fish farming and its role in nutrition. This is based on a conservative assumption that only a small percentage of families will become involved in the school pond work, with an average of 10 students and 5 mothers per school. Of course, more may become involved in the program, although it will be an extracurricular activity. Our metric will be the number of students, teachers, and women trained, and we will document that through record keeping at the schools.

Success of this project will be assessed by tests done in schools before and after training at each participating school. The training will be considered successful if there is a significant improvement in the knowledge on fish culture demonstrated by students and teachers participating in the training.

Deliverables

Training of 40+ students and 20 adult women through school pond programs at 4 schools. These numbers reflect trainees for this investigation and this time period only and do not account for the numbers of potential beneficiaries over time. Also, a curriculum will be developed for educating students about fish culture, which will serve as the basis for future expansion to additional schools.

Research Design

Location of work

Public schools have not yet been selected but will be chosen from schools in Kathar and Kawasoti.

Methods

- A 200 m^2 pond will be constructed for four schools, two in each district.
- Carps and tilapia will be provided for each school from nearby government fish hatcheries, and will be stocked in each pond at normal densities. The seven carp species include common (*Cyprinus carpio*), silver (*Hypophthalmichthys molitrix*), bighead (*Aristichthys nobilis*), grass (*Ctenopharyngodon idella*), rohu (*Labeo rohita*), naini/mrigal (*Cirrhinus mrigala*), and Bhakur/Catla (*Catla catla*) at a combined density of 7000 fish/ha. Fewer species are usually cultured since fingerlings are not always available for all of these species. Tilapia (*Oreochromis niloticus*) will be stocked at 0.3 fish/m2. The materials necessary to maintain ponds, including feed and fertilizer, will also be provided to each school system.
- A course of study will be developed for teacher and student education on fish culture.
- School students and teachers will receive regular trainings from the PIs about pond construction and farming activities, with similar lessons for both groups, at least at project initiation. Trainings will be open to all students regardless of age or gender. Students and teachers will be responsible for long-term maintenance, sales, and income generated from the school ponds. Trainings of teachers and students will include fish pond construction, managing pond depth, pond preparation,

species choice, water color, fertilizing, feeding, growing, harvesting of fish, as well as nutrition education, including fish preparation and eating.

- Informal education activities include forming women's fish farming groups in the school community for each participating locality. An initial training workshop will be organized by the project team at each school with selected teachers, students and women's group. The topic will be the role of household aquaculture in family nutrition. Women's groups will participate in monthly discussions and training on nutrition, income-generation, and marketing practices associated with fish consumption and farming. The women's fish farming groups could ultimately work with the teachers and students to ensure the long term sustainability of the school ponds.
- Surveys will be designed to test the knowledge of students and teachers in fish pond production, as well as their knowledge about the benefits of fish nutrition. The survey will be administered before and after training given in each school pond system.
- As the project concludes, training of teachers and students at additional schools will be done by AFU faculty members, while the costs of new pond construction and materials will be borne using AquaFish funds or Nepal government assistance.

Schedule

Establish ponds and women's groups. 1 October 2013 through December 2014. Final report will be completed no later than 30 August 2015.

Deliverables

- Curriculum for teachers and students
- Monthly Training and practice on regular fish farming activities over one culture cycle for teachers and students (8 at each school)
- Workshop to teach women's fish farming groups about nutrition and income generation
- Occasional visits by investigators at the regular monthly meeting of women's groups (4 per district)
- As part of the final investigation report, a summary on women's fish farming groups and number of participants per group will be included

AFRICA PROJECT: GHANA & TANZANIA

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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 Investigations #2 and #5. Because of the role women play in the post-harvest sector, targeting them for the training in Investigation #1 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 Investigations #4 and #6 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 Investigations #4 and #6 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

Spat Collection and Nursery Methods for Shellfish Culture by Women (13QSD01PU)

Objectives

This work builds on eight years of efforts to develop a small-scale bivalve shellfish culture industry in Zanzibar to increase food security and family income with women being the primary participants. Specifically, this work will address one of the primary obstacles to further development of the small shellfish farms: how to obtain stock in a sustainable manner for the farms. Spat collection is one of the most sustainable and cost-effective methods to obtain stock for shellfish farms, hence methods will be tested to determine the best materials and timing for spat collectors, and test nursery methods to rear the collected spat. Women will also be provided training in other shellfish farming methods beyond the nursery stage.

Introduction

Zanzibar has recently been the site for innovative work that combines development of aquaculture with integrated coastal management and fisheries management to implement alternative livelihoods. Zanzibar consists of two main islands and a number of small islands in the East Coast of Africa. The total area of both islands is 2,643 km2 (Unguja 1658 km^2 and Pemba 985 km^2). The population is estimated to be around 1,300,000 people, growing at 3.1 % annually. Fishing is the most common coastal activity and is 95% artisanal, mostly operating in shallow water using traditional vessels and gear. However, the artisanal fisheries are now considered to be overfished (Jiddawi, 2012) which has stressed local villages and the economy. Alternative to fishing are a high priority of the national and local governments.

The residents of Zanzibar suffer from multiple nutrition and health issues related to poverty and marginalization. Of children under five years of age, 35% are stunted, 25% are underweight, and 6% are wasted, resulting in approximately 130 child deaths per day (ZPRP, 2002). This is one of the highest rates amongst areas in Tanzania. Nutritional problems include protein/energy, iodine and Vitamin A. Bivalve shellfish are good sources of protein, vitamins (C, B1, B2, B3, D) and nutrients such as calcium, iron, copper, iodine, magnesium, zinc, manganese and phosphorus. Hence farming of bivalve shellfish represents a direct means of improving nutrition through local consumption, as well as an indirect means since women also sell bivalve products to support basic family needs.

The proposed work builds on eight years of efforts to develop a small-scale bivalve shellfish industry led by women stakeholders in East Africa. These efforts have had successful results in that over seven coastal villages now engage in some form of bivalve shellfish farming.

Coastal women have traditionally utilized reef-gleaning of bivalves, other invertebrates and small fish as one of their livelihoods, and as the principal source of high protein food. This traditional livelihood is threatened by: 1) increasing populations; 2) migration of inland populations to the coast; 3) development for tourism which excludes villagers; and 4) over-fishing. Climate change may also affect women's livelihoods. For example, seaweed farming has been a mainstay for coastal women for over twenty years but recent disease outbreaks have lowered production (Msuya et al., 2007) and may be linked to increased sea surface temperatures. Since 1998, a team of partners, including the Institute for Marine Sciences (IMS), Tanzania Coastal Management Partnership (TCMP), and the Western Indian Ocean Marine Sciences Association (WIOMSA), have led efforts to improve marine resource management, improve coastal management, build awareness for ICM and conservation, provide alternative livelihoods, and conduct relevant research. These partners were supported by the national and local governments, and a wide array of universities and international donors.

Most recently, the partners were supported by the Coastal Resources Center of the University of Rhode Island (CRC/URI) and the Pacific Aquaculture and Coastal Resources Center at the University of Rhode Island (PACRC/UHH) to focus on protecting and sustainably utilizing the coastal shellfish resource. This work was supported by USAID through the Sustainable Coastal Communities and Ecosystems (SUCCESS) Program, along with other donors such as the MacKnight Foundation and the European Union ReCoMap (Regional Coastal Management Program). Successful efforts previously supported by USAID include:

- Establishment and community-based monitoring of Marine Protected Areas (MPAs) to protect cockle (Anadara spp.) populations, a mainstay of the coastal diet;
- Development of bivalve shellfish farming led by women farmers;
- Piloting of pearl production and production of half-pearl jewelry by women;
- Initial testing of spat collection methods for a variety of bivalve species; and
- Development of a cottage industry utilizing discarded mollusk shells to make jewelry.

This work has been modeled on the successful efforts to develop seaweed farming by women along the East African coast which is now a major coastal industry. Many of the women shellfish farmers have also engaged in seaweed farming, hence they have a basic knowledge of aquaculture. Shellfish farming has equal potential if technical support is provided so that existing methods can be refined.

Despite the success of the initiatives listed above, these are still new economic activities which continue to need technical support and further applied research to make more profitable, scale up and become more sustainable. These efforts support food security both directly and indirectly. Bivalve shellfish are an important source of protein and micronutrients for women and children. They are commonly the only sources of protein that this group can access on a daily basis. Shellfish are also one of the main sources of income for coastal women, and the new cottage industries of producing shell jewelry and half pearls has significantly increased women's incomes. It has been documented that Zanzibar women use income from these activities for children's school fees, food, and clothing and to improve their housing (Crawford et al., 2010; Haws et al., 2010). Hence stabilizing and scaling up bivalve culture offers a feasible approach to improving food security and income for coastal women and children.

Significance

Women have been leaders in coastal aquaculture in East Africa as being the first to culture seaweed, which has become the major type of coastal aquaculture. The shellfish farming development efforts started eight years ago were modeled on the seaweed farming efforts, both of which were supported by the research and extension efforts of IMS and WIOMSA. Shellfish farming was a natural activity for women to adopt since they were already familiar with many bivalve species due to their reef-gleaning activities. Initially women began shellfish farming in a low intensity fashion by placing smaller specimens of the bivalves they collected from reef areas in small, fenced-in enclosures in the intertidal area to allow these to grow to eating size. The purpose of the "fences", made of short stakes, was not primarily to contain the bivalves, but rather to designate the area claimed by the woman farmer and to prevent other intertidal users from treading on the enclosed bivalves. Subsequently they found that the stakes provided good substrates for spat collection, as high numbers of spat naturally attached to the stakes. These specimens were added to the "farmed" bivalves in the enclosed area. Women typically gather, consume and sell nearly every bivalve species (*Ostrea* spp., *Crassostrea* spp., *Isognomen* spp., *Donax* spp., *Anadara* spp.) found on the intertidal flats (~15 common species), including two species of pearl oysters, *Pinctada margaritifera* and *Pteria penguin* (Jiddawi, 2008). The latter two species have been utilized for half-pearl production on a limited basis on Zanzibar and Pemba Islands. Hence, unlike single species industries which target specific species for spat collection and hence encounter issues with high rates of collection of undesirable species, shellfish farmers in Zanzibar have the luxury of being able to utilize nearly all bivalve species collected on any spat collector. Of course, developing methods which

would optimize collection of the higher value species such as oysters and pearl oysters would be most advantageous.

Collection directly from the reef and intertidal areas and grow-out of small specimens is not necessarily the most sustainable method of obtaining stock for shellfish farms. Moreover, it does not allow for scaling-up farms. The women shellfish farmers in Zanzibar are at the point where scaling up would be possible if greater numbers of juvenile bivalves were available. Previous pilot spat collection studies helped identify several areas where spat fall may be high enough to support shellfish farms. This work will build on the preliminary efforts to conduct a one-year trial to confirm that these locations are adequate in terms of spat settlement rates and to elucidate annual patterns of spat settlement.

Quantified Anticipated Benefits
Quantifiable benefits will include: amount of spat collected, number of students and technicians trained, development of feasible spat collection methods, increased availability of information and increased interest in culture of native species.

Metrics
Number of institutions directly or indirectly benefiting from the training: 6
Number of individual participants in extension and technical training: estimated at 60
Number of communities benefiting from training: 8
Number of private businesses (including cooperatives and women's groups) benefiting from improved extension services: 10
Students involved: 2
Training modules produced: 1
CRSP newsletter articles: 1
Peer-reviewed journal article: 1

Activity Plan
Pilot studies in 2009-2010 assisted in locating several sites near the villages of Bwelo and Nyamanzi on the Fumba Peninsula of Zanzibar where spat settlement rates on artificial collectors were relatively high. Bewelo and Nyamanzi were among eight villages participating in previous bivalve and pearl culture development work and their residents were among the most active in the participatory research. Approximately 200 women on the Fumba Peninsula have participated or benefitted from past aquaculture development efforts. Similar experiments were also conduct near Tanga on the Eastern Coast of Tanzania and showed promising results. Improvement of spat collection methods will have regional benefits.

Spat collection experiments will be conducted by establishing submerged long lines in two areas and deploying 50 spat collectors every month over a one year period. Three different spat collection materials will also be tested. This will allow researchers to determine the best time of year to deploy collectors and which material results in the highest level of spat settlement. The latter is more complex than it may appear as results from spat collection for pearl oysters in the Pacific suggest that while many materials appear to be suitable in terms of the initial spat collection rate, some types may result in juveniles detaching themselves or being more vulnerable to predation. Collectors will be inspected two months after deployment to obtain an estimate of the number of juvenile bivalves, which have attached and to identify these by species. Four months after deployment, the collectors will be removed from the water and all adhering bivalves counted and identified. The juveniles produced in this manner will be used in the nursery experiments. Two types of cages will be tested to determine which results in the highest survival and growth of juvenile bivalves. Data on water quality (temperature, salinity, turbidity) will be collected at each experimental site. Women from the two communities will participate in all aspects of this work and will be trained in the technical details of spat collection and nursery rearing.

Statistical Analysis

Analyses will be performed using the Statistical Package for the Social Sciences Version 10.1 (SPSS 10.1). Data on spat collection rates and survival will be tested by month and by the type of the collection material used. Data from the nursery trial will be tested to determine which cage type may result in higher survival and growth. In all cases, significant results will be followed by a comparison of means using the Least Significant Difference (LSD) Test. Normality and homogeneity of variance tests will be performed on raw data. Sample distributions violating assumptions will be log-transformed before analysis. Data, expressed as percentages, will be arc sine-transformed before analysis. All differences will be regarded as significant at $P < 0.05$.

Schedule

Work will start in July 2013 with establishment of the long-lines and procurement of other materials. Spat collectors will be deployed in August 2013 and continued through July 2014. Nursery trials will begin four months after the first juveniles are removed from the collectors; this is expected to occur in December 2013 or January 2014.

AFRICA PROJECT: KENYA & UGANDA

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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

Approaches to Inform, Motivate, and Advance Small and Medium-scale Fish Farmers: Building Industry Capacity Through Cell Phone Networks, Training, and Market Participation (13BMA04AU)

Objectives

1. Assess fish farmer needs and expectations for cell phones as a source of information, technical guidance, and applications.
2. Develop a program of technical collaboration among researchers, government technical staff, and cellular providers to advance aquacultural development.
3. Build on existing farmer-based institutions to use national trade shows, train-the-trainer, symposia, and other events to stimulate value chain development and attention to proven production practices.

Significance

Improving agricultural productivity is one of the most pressing issues for developing regions. Although mobile phones are no silver bullet, their widespread availability and flexibility position the technology as a necessary component of sustainable improvements in aquaculture. Coupled with corresponding innovation in existing social and institutional arrangements, mobile phones have the potential to make significant contributions to increase income for small-scale fish farmers. As mobile phones converge with other mobile devices such as netbooks and tablets, the opportunities will proliferate. Affordability will remain an issue, but cell phone capability and market penetration will grow.

Mobile phones seem to influence the commercialization of farm products. Subsistence farming is notoriously tenuous, but smallholder farmers, lacking a social safety net, are often highly risk averse and therefore not very market oriented. A study from Uganda found that market participation rose with mobile phone access (Muto and Yamano, 2009). Although better market access can be a powerful means of alleviating poverty, the study found that market participation still depended on what producers had to sell. Perishable bananas were more likely to be sold commercially than less-perishable maize.

Old style extension approaches must be supplanted (or at least supplemented) by mechanisms that provide for widespread dissemination of technical information to stimulate and support the adoption of productivity increasing practices. Cell phones are already recognized as powerful tools in food production. Technical guidance, product assembly, and price discovery are but three of the many fundamental applications of communication advances in aquaculture. Fishers and farmers use cell phones to get market prices to know where to sell products. Fish farmers use them for extension support and to arrange for feed and seed.

Cell phones are quickly transforming markets in low-income countries. One study assessed the impact of mobile phones on grain market performance. Aker (2008) finds that the introduction of mobile phones is associated with a 20-percent reduction in grain price differences across markets, with a larger impact for markets that are farther apart and those that are linked by poor-quality roads. Cell phones also have a larger impact over time: as more markets have cell phone coverage, the greater the reduction in price differences. This is primarily due to changes in grain traders' marketing behavior: cell phones lead to reduced search costs, more market information, and increased efficiency in moving goods across the country.

In one system for coffee producers, short message service (SMS) messages are sent to users' mobile phones every morning with the offers and grades available for purchase on that day. At the end of the day, users receive a text message with details of what actually took place. The Kenya Marine Fisheries Service is developing a SMS system for sharing marketing data from fish landings and other marketing points.

Other applications in aquaculture may include sourcing the availability of fingerlings, placing orders for seed stock, and otherwise coordinating stocking and harvesting of fish.

In Malawi, Katengeza et al. (2013) found cell phone use positively affected by literacy, distance to local market, land size, current value of assets, crop income, and region. Intensity of use is conditioned by gender, participation in agricultural projects, and ownership of a mobile phone, current asset value, and distance to nearest public phone services. Asset endowment plays a critical role in enhancing adoption of mobile phone technology. Gender disparities significantly affect adoption as most women have limited access to assets. In Kenya, M-Farm is a mobile service that connects farmers with one another, because peer-to-peer collaboration can improve market information and enhance learning opportunities (World Bank, 2013). These services are intended to improve agricultural marketing, particularly for women. The Village Phone program provides microloans to rural entrepreneurs who purchase a mobile phone, long-range antenna, solar charger, and airtime (World Bank, 2013). The recipient earns a livelihood by operating a phone kiosk in areas underserved by mobile networks. As is typical in microfinance, the loan recipients tend to be women.

Martin and Abbott (2013) examined the diffusion and perceived impact of agricultural based mobile phone use among small to medium size limited resource farm holders in Kamuli District, Uganda, where 42% of farm households now have a mobile phone, more than half of the farmers were using their mobile phones for farm purposes. The sought agricultural inputs, obtained market information, monitored financial transactions and used it for agriculture emergency situations. Slightly less than half were consulting with experts via mobile phones.

Men tended to adopt mobile phones earlier than women and those with more education were more likely to use SMS text features. Women were less likely to use the calculator function, perhaps due to a lack of numerical literacy training. Those who were members of agricultural groups were more likely to use their mobile phones for a variety of purposes. The study identified a number of unique uses being made of mobile phones, including taking photos of agricultural demonstrations, using the loudspeaker function to permit a group of farmers to consult with an expert, recording group members pledging when they will repay loans, and storing data such as the date hens should start laying eggs (Martin and Abbott, 2013).

Although mobile phones continue to evolve quite rapidly, the evidence suggests that they can promote improved livelihoods through networking and informing previously unconnected portions of the population. The evidence comes from users' own rapid grasp of the technology's potential (Kerala's fishers using phones to seek optimal markets for their catch) and from planned efforts originating from commercial information providers and development practitioners (as in market information and insurance programs). Price information is more complicated than it might seem. Bid prices, or "asked" prices, versus actual strike prices (where money and fish change hands) are quite different things. The question is: can cell phone networks help provide some order, transparency, and certainty to aquaculture markets in Africa?

The present study develops base information about the needs and interests of fish farmers in order to induce public agencies, nongovernmental organizations, and cellular service providers to facilitate the use of cell phones as a means to guide, coordinate, and instruct fish farmers.

Quantified Anticipated Benefits

- Availability of text-based fish market and fingerling supply information
- New extension mechanism for reaching fish farmers on broad-scale
- Augmented value chain for tilapia and other species resulting in added farm-level income

Research Design and Activity Plan
One study and two activities are planned.

Study 1: Cell-based Information Needs Assessment
We use qualitative approaches to map the aquaculture knowledge and information system.

Location of work
Objective 1 will be addressed through a series of six focus group interviews conducted in focal fish farming regions across Uganda.

Methods
We will work with area fisheries officers to assemble 8-12 active fish farmers to participate in focused group interviews cell phone use in aquaculture. The most common purpose of a focus group interview is to provide an in-depth exploration of a topic about which little is known. For such exploratory research, a simple descriptive narrative is quite appropriate and often all that is necessary. It is common for focus group interviews to be used for purposes of developing hypotheses that are then tested or validated with other types of research. For example, a focus group may yield hypotheses that are tested through a survey of the population of interest. The main deliverable for this study is a report summarizing the main themes and perceptions of the participants (Stewart, 2013).[1]

Trained Ugandan graduate students will lead the interviews in local languages. Teams of interviewers will lead the discussion following a flexible format based on an interview guide of topics developed from the literature and previous experience in Uganda. The notes, observations, and verbatim quotations will be compiled in English with translation as appropriate. We envision at least one Makerere M.S. thesis will emanate from this work.

Study 2. Cell-based Information Supply Development
Objective 2, the project will hold a series of three small conferences in selected locations where agricultural cell-based information systems are in operation or advanced stages of development. One of the conferences will be exclusively focused on cell phone access, use, and potential among women.

Location of work
Three day-long conferences will be held in Gulu, Jinja, and Kampala, and will bring together NGO technicians, public agency personnel, and project participants in a series of presentations, dialogues, and convergent prediction exercises that will inform and guide subsequent efforts to design and deliver cell-based information.

One of the conferences will be exclusively focused on cell phone access, use, and potential among women. We will seek to involve women professionals from the cell phone industry, women in aquacultural businesses and farming, and women professionals from the civil service serving agriculture. The workshop objectives are to elucidate the ways that women lead and participate in aquaculture, to identify emerging uses and applications that are particularly helpful to women, and to suggest paths for technology development and government service that will be particularly beneficial to women in aquaculture.

Methods
We will use focused group interview techniques to address an established list of topics, albeit in the order of the group's interests, experiences, and capabilities. The material will be transcribed by graduate

students and the content organized as a database to be sorted and analyzed with Atlas.ti or a similar program. The report will summarize the perspective of knowledge information industry participants about the way forward for cell phone technology in Uganda.

Study 3. Advancing Aquaculture Industry Development
Location of work
Training events will be held at various locales to advance the development of the aquaculture industry in Uganda. The primary venue will be the Annual Fish Farmer Conference and Trade Show that is usually held in Kampala.

Methods
A central feature of underpinning the growth of aquaculture production and expertise in Uganda is the Annual Fish Farmer Conference and Trade Show. The project will continue to support the event through participation of project personnel and outside speakers. To complement this event, we will hold a training session for selected, invited trainers from other projects and organizations that will focus on water quality and environmental management issues in aquaculture. Auburn University Professor Dr. Claude Boyd will lead this annual 1.5-day training event.

We also will hold a technical symposium on new approaches to technical assistance in aquaculture to link representatives of cellular providers, projects, nongovernmental organizations, and public agencies in Kampala. This meeting will be held as an event immediately preceding the Annual Fish Farming Conference and Trade Show. The meeting will provide a venue to sharing experience and expertise in the broader context of agriculture with the intent of using the models and experiences as guidance for services for fish farmers. University of Georgia Engineering Professor Dr. E.W. Tollner will provide leading presentations and participate in the discussion. He also will provide lectures at Makerere University to faculty and students on pond construction, water management, and other engineering aspects of aquaculture.

Schedule

Task	8/2013	11/2013	2/2014	5/2014	8/2014	11/2014	2/2015	5/2015	
Focus groups	x	x	x	x					
Technical conference		x	x	x					
Training					x	x	x	x	

Deliverables

Item	Mechanism (e.g. podcast reports factsheets etc.).
Results of focus groups	Journal article
Farmer leaflet	Tip sheet for farmers
Training program on fish production	Joint exercise with Chinese donor group at Kajjansi
Review of MU's aquaculture curriculum;	Report chapter from joint exercise with Makerere faculty and administrators resulting
MU aquaculture degree strategy (undergraduate and/or graduate);	Report chapter from joint exercise with Makerere faculty and administrators resulting
Needs assessment for MU farm training facility with aquaculture ponds.	Report chapter from joint exercise with Makerere faculty and administrators resulting

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