

DISSEMINATION OF AQUAFISH INNOVATION LAB TECHNOLOGIES FOR IMPROVING FOOD PRODUCTION EFFICIENCY AND LIVELIHOODS OF THE PEOPLE OF BANGLADESH

Mitigating Negative Environmental Impacts/Activity/16MNE02NC

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ABSTRACT

The main goal of this extension and outreach activity is to promote improvements in management practices and new technologies developed by the AquaFish Innovation Lab that will allow farmers to enhance the efficiency and diversity of seafoods they produce while increasing their incomes and accessibility to nutrient rich foods. To this end, a series of 6 workshops and group training sessions was conducted to disseminate promising technologies. This included research on: 1) reduced feeding strategies for tilapia monoculture and polyculture with major Indian carps; 2) brackish water culture of *Pangasius* catfish and tilapia-*Pangasius* polyculture as a livelihood alternative for coastal farmers impacted by salinity incursion and contamination of freshwater farming systems; 3) use of locally-produced formulated diets to reduce costs and improve production efficiency of *Pangasius*; 4) integration of Mola, a small indigenous fish, and dyke cropping in traditional gher-pond freshwater prawn culture for production of nutrient rich fish and vegetables for home consumption; and 5) semi-intensive polyculture of Koi and Shing with Indian major carps as a new technology for sustainable production of high value, nutritious fishes. Presentations and extension leaflets outlining new and improved technologies for culturing fish and integrating vegetables in fish production were provided at the workshops. This along with industry stakeholder input, including from farmers who worked with the investigators on field trials, could help expand application of the new technologies to fisheries and aquaculture communities. The workshops were conducted in Mymensingh region of Northcentral, and in Barisal and Khulna regions of Southwest Bangladesh. Approximately 450 individuals participated in the workshops or training sessions. Farmers and industry stakeholders, including a large number of women constituted the majority of participants. Other participants came from 13 different NGOs, 7 universities, and 5 government institutes or agencies. A National Workshop focused on disseminating research impacts to government agencies and NGOs to better advance and promote upscaling of technologies and policies that improve resilience and outcomes of communities dependent on aquaculture and fisheries for their livelihood. A series of short-term training sessions also worked directly with women to include the importance and nutritional value of fish and of vegetables for family health and how contributions of Mola and vegetable dyke cropping can improve nutrient consumption and household livelihoods. Collectively, the extension and capacity building activities should go a long way toward expanding the new technologies to farming communities that can improve food security and nutrition of the Bangladesh people.

INTRODUCTION

Bangladesh is one of the most densely populated countries in the world with many living in abject poverty. Many of the women and children are malnourished with 38-55% exhibiting vitamin or mineral deficiencies and most relying on cereals (rice) for their nutrition. Aquaculture and fisheries make up a large proportion of employment opportunities for a majority of Bangladeshis in rural areas. Aquaculture in Bangladesh is considered a high food security priority for enhancing dietary nutrition and improving the economic livelihoods for its poorest citizens. Sustainable aquaculture is particularly important in the coastal plain regions of Southwest Bangladesh, where poverty is exceptionally high and the region is plagued by frequent flooding, saltwater incursion, and extreme weather (cyclones, seasonal drought, high temperature fluctuations) which are linked, in part, to global climate change. Aquaculture production in these regions and throughout Bangladesh face significant problems which directly threaten the lives and economic livelihoods of local farmers. These include: limited production of nutrient-rich foods available for direct consumption, poor productivity and high mortality rates, excessive and costly feed inputs leading to poor economic return, poor pond management leading to low water quality and environmental degradation, and limited diversification of aquaculture products. Our research is aimed at remediating some of these issues. Here we will disseminate the most promising results of our AquaFish Innovation Lab research in Bangladesh to farmers and their communities through a series of workshops and training sessions.

The main goal of this extension and outreach activity is to promote significant improvements in management practices and new technologies that will allow farmers to enhance the efficiency and diversity of seafoods they produce while increasing their incomes and accessibility to nutrient rich foods. These technologies incorporate practical methods for intensifying fish production in a sustainable manner while promoting production of fishes with high nutrient value. They also provide new ways to grow fish in environments impacted by global climate change, namely in water bodies afflicted by rising salinity. Among various projects, previous AquaFish Innovation Lab research shows, for instance, that incorporation of endemic, nutrient-dense small indigenous fish species (SIS) into gher-prawn farming coupled with pond dyke vegetable production provides farmers additional crops for home consumption as well as income from market sales, all while improving production of the prawn cash crop. Reducing daily ration of feed or feeding on alternate days can dramatically reduce costs and increase incomes for farmers without impacting overall yield of the cultivars produced. This research along with other studies indicate impacts of fish culture on environmental water quality and fish stock health can be improved through better management of feed inputs and by the incorporation of semi-intensive and polyculture production practices.

OBJECTIVES

1. Provide workshops and group training sessions to disseminate promising technologies derived from AquaFish Innovation Lab research.
2. Produce and distribute leaflets as outreach documents for extending aquaculture technologies to local farmers and the general public.
3. Work with local university, government, and NGO representatives to provide these outreach opportunities to the general public to enhance sustainability of project impacts.
4. Improve food production efficiency in an environmentally sustainable way to enhance nutrient consumption, incomes and the livelihoods of the people of Bangladesh.

MATERIALS AND METHODS

Location

Workshops were provided in 4 major regions of Bangladesh including where improved aquaculture management practices and new technologies were developed. The workshops were undertaken in the greater Mymensingh, Khulna, and Barisal regions of Bangladesh. A single, national workshop was held in Dhaka, the capital of Bangladesh. The workshops were cosponsored by local Bangladesh

Agricultural University, Khulna University, Patuakhali Science and Technology University and held at the university, village, or conference center in Dhaka, Bangladesh.

Methods

We worked with local university, government, and NGO representatives as well as extension agents to advertise the workshops and training sessions. These individuals where possible also attended, helped promote, and contributed to the outreach activities given to farmers and other stakeholders. This allowed for disseminating information in the best and most accepted methods in the relevant areas. We used a combination of extension leaflets or brochures developed by the PIs as well as presentations outlining the improved management practices and aquaculture technologies promising aquaculture technologies. Materials were also distributed to local extension agencies and NGOs. Where applicable, pond-side training was also conducted.

Five 1-day workshops and a series of training sessions were provided in each of the four regions of Bangladesh: Khulna, Patuakhali, Mymensingh, and Dhaka (a total of 6 workshops). Presentations focused on the aquaculture developments that came from AquaFish research in each of the regions (see below). At least 25 individuals, and in most case far more attended the workshops. We encouraged women in the farming community to attend to learn about better aquaculture practices, as they are often responsible for taking care of food crops and provide nutrition to their children. We invited farmers with whom we conducted on-farm trials to test new technologies and their benefits. Farmer-to-farmer extension of new culture technologies can increase the likelihood that farming households incorporate the new practices into their operations. Our participant farmers could also serve as liaisons to other farmers in the area should they want to adopt new practices.

Provisions for transport to workshops was provided to those who required it. Lunch, snacks, tea, and soft drinks were provided for the day's events.

The title, date(s) and location of the workshops are as follows:

Workshop 1:

Title: Training Workshop on Culture of Pangas, Tilapia, and Koi in Hypo-saline Water

Date: November 28, 2017

Location: Hazipur (Village), Kalapara (Upazila), Patuakhali (District), Barisal (Division), Bangladesh

Workshop 2:

Title: Training Workshop on Culture of Pangas, Tilapia, and Koi in Hypo-saline Water

Date: December 01, 2017

Location: Anipara, Kalapara, Patuakhali, Bangladesh

Workshop 3 (Four training sessions, 25 persons/session):

Title: Integration of Nutrient-rich fish SIS and vegetables with Prawn-Carp Gher farming in Southwest Bangladesh

Date: December 15, 2017; December 26, 2017; January 5, 2018; January 15, 2018

Location: Khulna University, Khulna, Bangladesh

Workshop 4:

Title: Integration of Nutrient-rich fish SIS and vegetables with Prawn-Carp Gher farming in Southwest Bangladesh

Date: December 21, 2017

Location: Khulna University, Khulna, Bangladesh

Workshop 5:

Title: Polyculture of Air breathing Fishes, Koi, and Shing with Indian Major Carps for Enhancing Income and Dietary Nutrition while Reducing Environmental Impacts

Date: May 31, 2018

Location: Bangladesh Agricultural University, Mymensingh, Bangladesh

Workshop 6:

Title: Dissemination of AquaFish Innovation Lab Findings

Date: January 15, 2018

Location: Krisibid Institute, Farmgate, Dhaka, Bangladesh

RESULTS AND DISCUSSION

Workshops 1 and 2

There were 47 farmers who participated at Workshop 1 (17 women, 30 men) and another 50 farmers at Workshop 2 (20 women, 30 men). Additionally, 4 local representatives and 4 faculty and 5 students from Patuakhali University of Science and Technology attended each of the workshops providing a total of 118 participants at both workshops (Figure 1). The workshops disseminated on-farm research that demonstrate *Pangasius* catfish (*Pangasius hypophthalmus*) can be grown in brackish waters as effectively as in freshwater ponds. This provides a new livelihood alternative for farmers impacted by rises in surface water salinities seen in coastal regions of Bangladesh. Incorporating less costly, locally made formulated feeds also provides additional cost benefits and improves returns on investment for culturing *Pangasius*. This was then followed up by discussions on research showing that Nile tilapia (*Oreochromis niloticus*) is the more optimal candidate for polyculture with *Pangasius* in hyposaline waters with *Pangasius*-Koi (the freshwater climbing perch, *Anabas testudineus*) polyculture providing the second greatest profit margin relative to *Pangasius* culture alone. Polyculture of all three species together is less viable, likely from competition between Koi and tilapia. Participatory discussion sessions that included input from farmers who were involved in the demonstration research studies were also conducted and farmers had the opportunity to visit the field sites where research took place to demonstrate the methods and benefits of the new culture technologies.

Workshop 3

From October 2017 to January 2018, 100 farmers were trained on technologies for integrating Mola, a small indigenous fish with high nutritional value, and dyke cropping for vegetable production into prawn-carp-gher farming systems. Incorporating Mola, carps, or both into current prawn-gher farming practices does not adversely impact, but in fact enhances the production of prawn. In utilizing these practices, farming families can obtain additional nutrients from domestic consumption of Mola while improving production of prawn as a cash crop. AquaFish Innovation Lab research also established that pond muds derived from prawn-fish polyculture in gher are more effective than soil in producing vegetables on pond dykes, providing an additional source of nutritional food for consumption or sale. The best types of fertilizers to use in growing vegetables (winter and summer types including fruits) and fish in the integrated aquaculture-agriculture system was disseminated.

The training was conducted in four slots with 25 farmers per slot and more than 63% of the participants were female (63 female, 37 male). Women are primarily responsible for nutrition in farming households and also contribute to gher farming by feeding fish and cultivating dyke vegetables. Training was provided to the participants to include the importance and nutritional value of fish (with emphasis on SIS) and of vegetables to family health and how contributions of Mola and vegetable dyke cropping can improve nutrient consumption and household livelihoods. Participants were provided training on nursery and grow out pond preparation, dyke cropping, nursing of prawn post-larvae, liming importance and dosage, fertilization dosage and application, fish stocking, feed,

and feeding, pond productivity, sampling and regular health checks, common disease/parasites, safe harvesting, and proper washing, transport, and marketing. Farmers received training on record book keeping as well. Leaflets outlining the new integrative agriculture-aquaculture technologies developed from AquaFish Innovation Lab studies were distributed among participants. Local fish farmers have been or are inspired to incorporate Mola fish and dyke vegetables into their gher culture production systems through discussions and observations of farmers who undertook initial testing trials. Many have initiated the new culture technologies for integrating Mola and dyke vegetables into their traditional farming systems.

Workshop 4

The AquaFish Innovation Lab research team from Khulna University organized an interactive workshop on December 21, 2017 entitled “*Integration of Nutrient-rich small fish and vegetables with Prawn-Carp Gher farming in Southwest Bangladesh*” to disseminate the outcomes of the new technologies developed (Figure 2). More than 50 attendees from various organizations and the local farming community attended the workshops. They included representatives from the Department of Fisheries (DoF), Bangladesh Fisheries Research Institute (BFRI), Department of Agriculture Extension (DAE), Soil Resource Development Institute (SRDI), various development NGOs (WorldFish, SOLIDARIDAD, Blue Gold, Winrock International, Shushilan, Rupantor, Prodipon, Nobolok, Ashroy Foundation), faculty from various universities, and local gher farmers. Leaflets on the research findings were distributed to the participants. As the Department of Fisheries is the government organization responsible for disseminating fisheries-related technologies to local farmers, the leaflets were also distributed to officers at various levels within the department, e.g. Deputy Director, District Fisheries Officer, Upazilla Fisheries Officers of Khulna Division. We believe that through these sectors thousands of farmers will be informed of the new technologies. Information from the workshop was also highlighted in six different Bangladeshi newspapers.

Workshop 5

This workshop disseminated research showing: 1) Koi and Shing (*Heteropneustes fossilis*), air breathing fishes high in commercial and nutrient value, can be grown more profitably in polyculture with major Indian Carps (Rohu and Catla) than in monoculture in semi-intensive pond production systems, 2) reducing daily feed ration by 50% from that typically used in intensive monoculture provides additional cost benefits to the polyculture of these fishes, and 3) polyculture of Koi-carp with Shing may be even more profitable than Koi-carp polyculture. The workshop had 82 participants that included 70 fish farmers and hatchery operators in the Mymensingh region of central Bangladesh as well as fisheries managers, students, journalists, and faculty from Bangladesh Agricultural University (BAU) (Figure 3). The workshop was held for a full day at BAU where the new technologies and their application were presented to farmers. Extension leaflets were provided and farmers had the opportunity to discuss their experiences and successes as well as methodology for applying the new technologies to their aquaculture operations. Field visits to the research farm were also provided to all participants. The workshop received press coverage through <http://shobujbangladesh24.com> (<http://shobujbangladesh24.com/?p=27889>).

Workshop 6

This National workshop was undertaken in Dhaka, the capital of Bangladesh, and focused on disseminating all aquaculture and fisheries technologies developed by the AquaFish Innovation Lab project to primarily government agencies (Department of Fisheries, Bangladesh Fisheries Research Institute, Department of Agricultural Extension) as well as NGOs (WorldFish, Helen Keller International, Sushilan, BRAC Centre, Hortex Foundation, CARE) (Figure 4). This is critical to the overall exit strategy, aimed at maintaining support for programs begun by the AquaFish Innovation Lab, and to advance and promote upscaling of technologies in the aquaculture and fisheries sectors developed by the AquaFish Innovation Lab. There were 67 participants at the workshop from various

government and nongovernment agencies, universities, and private industry. The Director General of the Bangladesh Department of Fisheries and colleagues attended the workshop. The Director presented a synopsis on the state of fisheries and aquaculture in Bangladesh and the importance of AquaFish Innovation Lab research in promoting priority areas of growth in the sector needed for food security. Highlights on novel and improved fish and shellfish culture technologies for enhancing food production efficiency and sustainability while increasing household incomes and fish consumption were covered at the workshop by AquaFish Innovation Lab researchers and their partners.

The technologies developed and disseminated at the workshop include:

1. Reduced feeding strategies for tilapia monoculture and polyculture with major Indian carps.
2. Brackish water culture of *Pangasius* catfish and tilapia-*Pangasius* polyculture as a livelihood alternative for coastal farmers impacted by salinity contamination of freshwater farming systems.
3. Use of locally produced formulated diets to reduce costs and improve production efficiency of *Pangasius*.
4. Addition of Mola and dyke cropping to traditional gher-pond freshwater prawn culture for production of nutrient rich fish and vegetables for home consumption.
5. Semi-intensive polyculture of Koi and Shing with Indian major carps as a new technology for sustainable production of the high value, nutritious fishes.

Several farmers who undertook aquaculture studies with AquaFish Innovation Lab researchers presented their experiences and successes in producing and marketing aquafoods. Overall, this workshop was very successful in that it conveyed the impact of research done by the AquaFish Innovation Lab and provided a discussion of future needs and opportunities for promoting food production and nutrition in Bangladesh.

CONCLUSION

Six workshops or short-term training sessions were undertaken to disseminate AquaFish Innovation Lab technologies for improving food production efficiency and livelihoods of the people of Bangladesh. The workshops were carried out in three regions of Bangladesh where research established novel and improved methods for fish production. The regions were Mymensingh of Northcentral Bangladesh and Khulna and Barisal in Southwest Bangladesh, the latter reflecting the high priority zone of influence for the USAID Feed the Future program on Global Hunger and Food Security. Approximately 450 individuals participated in the workshops or training sessions. Farmers and industry stakeholders, including a large number of women constituted the majority of participants. Other participants came from 13 different NGOs, 7 universities, and 5 government institutes or agencies. Faculty, students, farmers, and others provided presentations on the most promising new aquaculture management practices and technologies that were shown to improve fish yields, farmer incomes, and consumption of nutritious seafoods. Some also promote resilience, including mitigating impacts of seawater incursion along coastal lands by incorporating fish that can be grown in brackish water environments. Several extension leaflets produced by AquaFish Innovation Lab researchers that outline new and improved management practices were distributed to participants, including NGOs and government agencies whose goals are to promote and facilitate upscaling of technologies. Collectively the activities conducted herein, including that derived from a National Workshop, should go a long way toward extending aquaculture technologies to Bangladesh communities that were tested and shown to improve food security and nutrition in Bangladesh.

FIGURES



Figure 1. Pictures from workshop 1 and 2 held in the Barisal region of Bangladesh. Includes a participant farmer speaking of his experience with pond trials conducted with AquaFish Innovation Lab researchers.



Figure 2. Chairwoman delivering a presentation at Workshop 4 held at Khulna University (left panel) and workshop participants representative of the farming community, aquaculture industry, NGOs, government fisheries agencies, university research and extension programs, and local media organizations.



Figure 3. Pictures of Workshop 5 participants at the conference venue (left panel) and at research field sites (right panel) at Bangladesh Agricultural University.



Figure 4. Some Participants at the National Workshop on Dissemination of AquaFish Innovation Lab Research (left panel). The right panel shows some of the faculty and students that makeup the AquaFish Innovation Lab Research Team in Bangladesh.

APPENDIX I. INVESTIGATIONS SUMMARY & ASSESSMENT

Appendix 1. AquaFish Innovation Lab 2016-2018 Investigation Summary and Assessment.

Investigation Code	Investigation Title	Lead US Project PI	Lead US Institution	Final Status*
16BMA01PU	Experimental Pond Unit Assessment in Tanzania	Kwamena Quagraine	Purdue University	1
16BMA02PU	Optimizing the Use of Commercial Feeds in Semi-Intensive Pond Production of Tilapia in Ghana; From Nursery to Grow-Out	Kwamena Quagraine	Purdue University	1
16BMA03UM	A Comparison of Monoculture and Polyculture of Tilapia with Carps for Pond Production Systems in Nepal	James Diana	University of Michigan	1
16BMA04UM	Developing New Systems for Periphyton Enhancement in Farmers' Ponds	James Diana	University of Michigan	1
16BMA05AU	Water, Water Quality, and Pond Bottom Soil Management in Ugandan Aquaculture	Joseph Molnar	Auburn University	1
13BMA01PU	Coastal Women's Shellfish Aquaculture Development Workshop	Kwamena Quagraine	Purdue University	1
13BMA05AU	Development of Low-Cost Aquaponics Systems for Kenya	Joseph Molnar	Auburn University	1
16SFT01UC	Pellet Feed Improvements Through Vitamin C Supplementation for Snakehead Culture	Robert Pomeroy	University of Connecticut	1
16SFT02NC	Nutritional Conditioning During Larval Development to Improve Feed Efficiency and Identify Beneficial Gut Flora in Tilapia	Russell Borski	North Carolina State University	1
16SFT03PU	Increasing Productivity of Nile Tilapia (<i>Oreochromis niloticus</i>) Through Enhanced Feeds and Feeding Practices	Kwamena Quagraine	Purdue University	1
13SFT02PU	Enhancing the Nutritional Value of Tilapia for Human Health	Kwamena Quagraine	Purdue University	1
13SFT06AU	Assessment of Growth Performance of Monosex Nile Tilapia (<i>Oreochromis niloticus</i>) in Cages Using Low-Cost, Locally Produced Supplemental Feeds and Training Fish Farmers on Best Management Practices in Kenya	Joseph Molnar	Auburn University	1
16IND01UC	Sustainable Snakehead Aquaculture in Cambodia	Robert Pomeroy	University of Connecticut	1
16IND02NC	Tilapia and Koi (Climbing Perch) Polyculture with <i>Pangasius</i> Catfish in Brackish (Hyposaline) Waters of Southern Bangladesh	Russell Borski	North Carolina State University	1
16IND03AU	Development of Captive Breeding, Larval Rearing Technologies and Management Practices for African Lungfish (<i>Protopterus aethiopicus</i>)	Joseph Molnar	Auburn University	1
16IND04MS	Develop a Conceptual Model to Evaluate the Potential Changes in Inland Food Fish Supply Under Various Global Climate Change Scenarios	William Taylor	Michigan State University	1

Appendix I: Investigations Summary & Assessment

Investigation Code	Investigation Title	Lead US Project PI	Lead US Institution	Final Status*
16QSD01UC	Genetic diversity of striped snakehead (<i>Channa striata</i>) in Cambodia and Vietnam	Robert Pomeroy	University of Connecticut	1
16QSD02UM	Improving Seed Production of Sahar (<i>Tor putitora</i>) in Chitwan Nepal	James Diana	University of Michigan	1
13QSD01PU	Spat Collection and Nursery Methods for Shellfish Culture by Women	Kwamena Quagraine	Purdue University	1
16HHI01NC	Better Management Practices for Mola-Prawn-Carp Gher Farming Integrated with Pond Dyke Cropping for Increased Household Nutrition and Earnings of Rural Farmers in Southwest Bangladesh	Russell Borski	North Carolina State University	1
16HHI02PU	Fish Consumption and Implications for Household Nutrition and Food Security in Tanzania and Ghana	Kwamena Quagraine	Purdue University	1
16HHI03UM	Outreach to Increase Efficiency of Aquaculture in Nepal	James Diana	University of Michigan	1
16HHI04AU	Women in Uganda Aquaculture: Nutrition, Training, and Advancement	Joseph Molnar	Auburn University	1
16HHI05MS	Determine the Role of Wild-Caught and Aquaculture-Based Inland Fisheries in Meeting Burma's Human Nutritional Needs	William Taylor	Michigan State University	1
16FSV01UC	Enhancing Food Safety and Household Nutrition of Women and Children through Aquaculture and Capture Fisheries in Cambodia and Vietnam in the Dry Season	Robert Pomeroy	University of Connecticut	1
16FSV02AU	Implementing and Assessing Cell-Based Technical and Marketing Support Systems for Small and Medium-scale Fish Farmers in Uganda	Joseph Molnar	Auburn University	1
16PDV01UC	Guidance and policy recommendations for sustainable snakehead aquaculture and aquatic resource management in Cambodia and Vietnam	Robert Pomeroy	University of Connecticut	1
16MER01PU	Enhancing the Functionality and Applicability of Fish Market Information System (FMIS) to Marine Artisanal Fisheries in Ghana	Kwamena Quagraine	Purdue University	1
16MER02AU	Assessment of Price Volatility in the Fish Supply Chain in Uganda	Joseph Molnar	Auburn University	1
16MNE01NC	Advancing Semi-Intensive Polyculture of Indigenous Air-Breathing Fishes, Koi and Shing, with Major Indian Carps for Enhancing Incomes and Dietary Nutrition while Reducing Environmental Impacts	Russell Borski	North Carolina State University	1
16MNE02NC	Dissemination of AquaFish Innovation Lab Technologies for Improving Food Production Efficiency and Livelihoods of the People of Bangladesh	Russell Borski	North Carolina State University	1

*Final Status of FIRs was determined based on the following criterias:

- 1- FIR fulfilled all AquaFish IL Management Team requirements (A. demonstrated that Work Plan objectives were met, B. complied with the report stucture instructions, and C. represented high quality work) by 15 June 2018, the deadline for inclusion in this Technical Report.
- 2- FIR was submitted, but did not meet all AquaFish IL Management Team requirements by 15 June 2018, and therefore was not included in this Technical Report.
- 3- FIR was not received by the AquaFish IL Management Team by 15 June 2018, and therefore was not included in this Technical Report.