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SCHOOL PONDS ENHANCE SCHOOL CURRICULUM AND IMPROVE HOUSEHOLD NUTRITION AND FOOD SECURITY IN NEPAL

By Lindsay Carroll
AquaFish Innovation Lab

Content contributions were provided by the following AquaFish partners: Dilip K. Jha, Narayan P. Pandit, Ishori S. Mahato, Madhav K. Shrestha, and James Diana

In Nepal, where 8% of the population is undernourished, AquaFish is working to improve food security and household nutrition by partnering with students, teachers, and women's groups while mentoring and teaching them about sustainable aquaculture production and health benefits of consuming fish. AquaFish researchers from the Agriculture and Forestry University in Nepal, and the University of Michigan and Oregon State University in the US, created school pond programs at public schools in the Chitwan and Nawalparasi districts. Four ponds were established and used to train teachers and school-age children from grades 8 to 10 on how to manage pond water levels; fertilize, feed, and harvest fish; and prepare fish for household consumption.

(Photo courtesy of James Diana)

Fish stocking at Nepal Higher Secondary School located in Tandi.

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AquaFish Trains Over 10,000 Participants

In just over 10 years, AquaFish trained 10,000 people using workshops, on-farm trainings, short-courses, and more!

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Alternative Feeds Research in Tanzania

Researchers investigate usage of legume leaves, maggots, and earthworms as protein sources in aquaculture feeds.

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To create linkages with the community, AquaFish organized two women's fish farming groups in the school communities. Members learned about the importance of household aquaculture for nutrition and income generation. Connecting the local women's groups to the school pond project spread the value of fish production and consumption among households and ensured long-term school pond sustainability.

The first phase of the school pond program trained 121 students (64 girls and 57 boys), eight teachers, and 44 women through women's groups. To measure knowledge transfer, students were given pre- and post-training tests. Only 4% of students scored 60% or better on the pre-test, but after participating in the curriculum and hands on training, 85% of students scored higher than 60%.

The installation and operation of the school ponds also piqued the interest of the surrounding communities. Local farmers and community members attended stocking and harvesting training events, where they asked for advice and materials required. Within a few months of receiving the training, neighboring farmers established ponds of their own.

In response to the community's increased interest, AquaFish expanded the project to include two additional schools, mentoring 83 more students (44 girls and 39 boys). Students and teachers at these schools received similar

(Photo courtesy of James Diana)

Women's workshop held in Kathar, Chitwan, Nepal.

Goings-on in the Pond

AquaFish Shares Research in Cambodia

AquaFish director, Dr. Hillary Egna, staff, and partners connect and engage with other agriculture experts, researchers, professionals, and students in Cambodia at the first ever International Sustainable Agricultural Intensification and Nutrition Conference. The conference was held at Royal University of Agriculture, an AquaFish partner institution, in Phnom Penh, Cambodia, 10-13 January 2018. The conference enabled AquaFish to discuss and share how sustainable aquaculture methods are increasing household nutrition and food security in Cambodia and beyond. Click here to read more!

AquaFish Bangladeshi Partners in the News

Shahroz Mahean Haque, Md. Ashraful Islam, and other AquaFish collaborators from Bangladesh Agricultural University, Khulna University, and North Carolina State University were featured in several Bangladeshi news articles for their recent workshop on the integration of nutrient-rich small fish and vegetables with prawn-carp gher farming in southwest Bangladesh.

During the last several years, AquaFish collaborators in Bangladesh have worked on several projects and innovations to increase household nutrition and earnings for rural farmers. At the workshop in December, they shared these results with over 50 stakeholders and several farmers shared their experiences using the new aquaculture methods. Read more about the workshop in English (translated by google) or in Bengali.

AquaFish Partners Publish Research in Asian Fisheries Science Special Issue

The newly established Gender in Aquaculture and Fisheries Section of the Asian Fisheries Society recently published an Asian Fisheries Science Special Issue, titled "Engendering Security in Fisheries and Aquaculture." The special issue includes research papers, technical papers, short communications, and extended abstracts based on presentations delivered at the 6th Global Symposium on Gender in Aquaculture held at the 11th Asian Fisheries and Aquaculture Forum in Bangkok, Thailand, 3-7 August 2016. Included in the issue are three short communications and one technical paper written by Dr. Hillary Egna, staff, and partners in Nepal and Bangladesh. Click here to read more!

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(Photo courtesy of James Diana)

Fish pond established at Kathar Secondary School located in Kathar, Chitwan, Nepal.

trainings on fish nutrition, pond establishment and farming activities, including pond fertilization and proper feeding, grow-out, and handling of fish. Seeing the benefits of the first phase to the neighboring community motivated researchers to continue to spread aquaculture knowledge and the benefits of fish for nutrition. In the next phase of the school pond program, researchers incorporated outreach efforts to areas surrounding the target schools.

Results indicate that the school pond program is contributing to the knowledge of science-based aquaculture in the curriculum, with the added bonus of after school interest in household ponds for the family. After the first year, pond ownership by the households of students increased by 4% and the number of times per year student households consumed fish increased by 47%. Surveys reveal that women and children living in homes with household ponds consume more than twice as much fish as homes without ponds. Most fish cultured in Nepal are consumed in the home; otherwise, pond owners share fish with friends, further contributing to improved nutrition and health among families in local communities.

(Photo courtesy of James Diana)

Student participant of the school pond curriculum at Janta Higher Secondary School in Kawasoti, Nepal poses with his mother in front of a pond they established within a few months of receiving AquaFish training.

Measuring the relative impact and success of not only trainings associated with the school pond program, but all other trainings held over the duration of the Nepal project was also important to the research team. Which is why researchers developed and distributed a survey to all locations where community members received AquaFish-supported trainings. The survey was designed to help determine if changes to fish culture practices occurred in these target areas and if information and innovations disseminated at AquaFish trainings or through the school pond curriculum contributed. Results are in and conclusions from the survey are coming soon, so stay tuned for more updates!

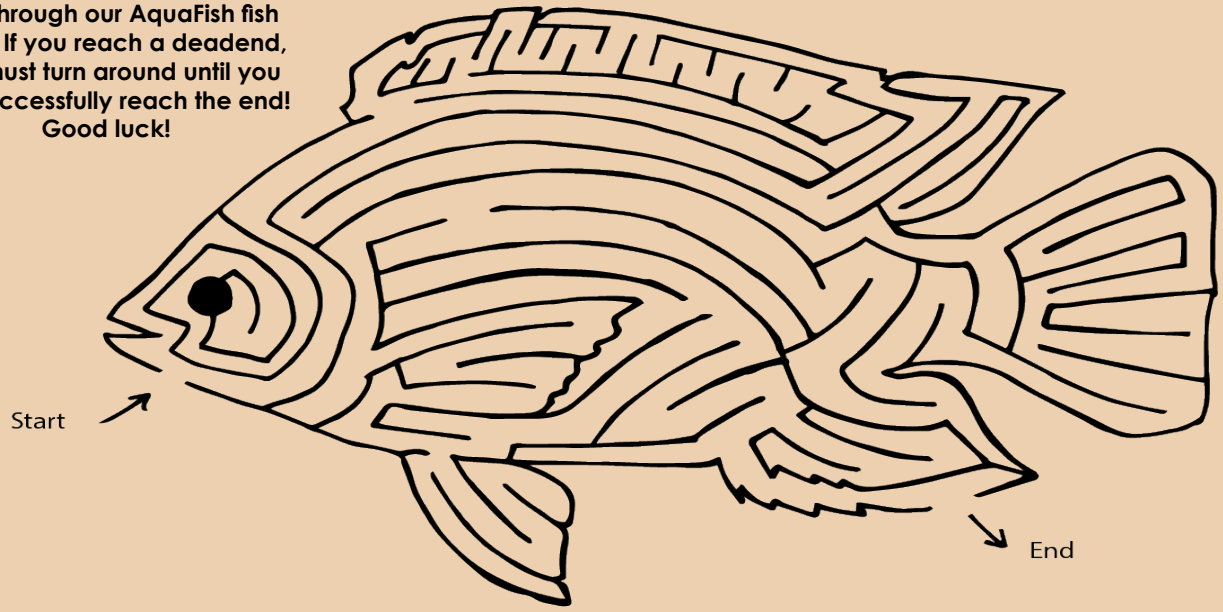
Overall, community members recognize the role of the school pond curriculum in improving their community and are seeing the added value among their villages. As one parent said, "We're so happy you [all] are doing so much for our village and the children." This project confirms that schools can serve as a foundation to empower women and youth with knowledge and skills on aquaculture to positively impact household nutrition and food security.

AquaFish work developing school pond curriculum in Nepal was featured in the United States Agency for International Development (USAID) Feed the Future Newsletter in November of 2016!

Read More Here!

aMAZ(E)ing Ponderings...

See if you can navigate your way through our AquaFish fish maze. If you reach a deadend, you must turn around until you can successfully reach the end! Good luck!



Illustrated by Haley Demmin, AquaFish Innovation Lab

AquaFish Trainings Reach Over 10,000 Participants

By Amanda Hyman, AquaFish Innovation Lab

Since 2008, AquaFish has trained over 10,000 people in over 350 training events held in 19 countries around the world. AquaFish values building and strengthening the capacities of institutions and individuals in partnering countries. These efforts focus on developing relevant knowledge, skills, abilities, and experience among a wide range of audiences along the value chain, including fish farmers, researchers, government officials, extension agents, and end-users. To this end, a central component of the AquaFish mission is to transfer research results, technologies developed, and best management practices through workshops, on-farm trainings, short-courses, and other such events.

By fostering wide dissemination of research results and technologies through these training events, AquaFish has enhanced local capacity in aquaculture and aquatic resource management to ensure long-term impacts at community and national levels. Dissemination of such results is key for increased capacity and augmented productivity of partner countries to contribute to national food and nutrition security. For example, in Nepal, AquaFish researchers address food security and household nutrition issues through extension programs at schools that train students, teachers, and women's groups in sustainable aquaculture production (Read more in article on page one). Beyond nutrition, advancements in aquaculture can contribute to improved profits for small-scale farmers. For instance, traditional feeds represent up to 80% of fish production costs, so many workshops have focused on best practices to reduce costs of feeds (e.g., feed ratios, fertilization rates, alternative feeds).

AquaFish partners continue their research and outreach efforts in eight countries: Bangladesh, Cambodia, Ghana, Kenya, Nepal, Tanzania, Uganda, and Vietnam. Through dissemination efforts to broad audiences, AquaFish is enabling communities in partnering countries to increase the efficiency of aquaculture and improve fisheries management in environmentally and socially acceptable ways.

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Highlights from 2017 training events where AquaFish trained over 500 individuals through 15 events!

(Photo courtesy of Dr. Kwamena Quagrainie)

Mobile phone training targeted toward market women in Ghana.

In Ghana, fish and their sustainable production are major contributors to food security and improved livelihoods. Lack of communication, of fish farmers and fishermen to markets, hinders such fish production. AquaFish researchers in Ghana, however, recently created a Fish Market Information System, a web-based tool that provides tilapia market information online as well as via voice and text messaging. Within the last three years, AquaFish researchers trained nearly 200 stakeholders on the application; they trained not only farmers, but buyers, input companies, consultants, and various training institutions. AquaFish researchers hope the technology and increased training will help decrease post-harvest loss of fish, increase farmers' profits, and improve overall market efficiency. Read more about AquaFish work with mobile apps here.

(Photo courtesy of AquaFish Innovation Lab)

AquaFish partner, Dr. Tran Thi Thanh Hien, leading an AquaFish training on seed production and snakehead grow-out.

In Cambodia, the government lifted a decade-long ban in 2016 on snakehead farming. To ensure the longevity and sustainability of snakehead farming in Cambodia, researchers from Can Tho University in Vietnam continued to train both Cambodian fish farmers and researchers at the Inland Fisheries Research and Development Institute on improved pelleted feeds for snakehead and more sustainable methods for breedings, weaning, and grow-out of snakehead. These newly transferred technologies and methods will decrease negative impacts of fish farming, while increasing profits for fish farmers. Read more about AquaFish work on snakehead here.

(Photo courtesy of AquaFish Innovation Lab)

Workshop in Bangladesh on culture of *Pangasius* in brackish water.

*In southern Bangladesh, many lands are suffering from seawater encroachment causing fresh water to turn saline. When the waters become salty, it damages natural environments, decreases fish farmer's production, and, in turn, causes declines in their income and food security. To combat this environmental change, AquaFish sought to culture native fishes, specifically Pangasius catfish (*Pangasius hypothalamus*), koi (*Anabas testudineus*), and Nile tilapia (*Oreochromis niloticus*), tolerant of hyposaline conditions. In 2017, AquaFish researchers trained over 150 farmers, university students, and government officials on their successful studies on polyculture in hyposaline waters. During these trainings, researchers brought in farmers already using the new techniques to share their experiences and successes. Stay tuned for final outcomes of this project.*

Plants, Bugs, and Other Such Feedstuffs: Alternative Protein Sources in Fish Diets

By Amanda Hyman, AquaFish Innovation Lab

Content contributions were provided by the following AquaFish partners: Sebastian W. Chenyambuga, Nazael Madalla, and Kwamena Quagraine

(Photo courtesy of AquaFish Innovation Lab)

Culture of housefly maggot meal.

AquaFish strives to investigate ways to make aquaculture sustainable, affordable, and accessible to small- to medium-scale farmers across the globe. Researchers in Tanzania have dug into ways to do just that with alternative protein sources for fish diets; specifically, they have investigated meal derived from leguminous trees (*Moringa oleifera*), housefly maggots (*Musca domestica*), and earthworms (*Lumbricus terrestris*) as sources of protein in Nile tilapia (*Oreochromis niloticus*) diets. Researchers explored these options because they are high quality, yet affordable ingredients. Traditional protein sources (i.e., fish meal and soybean meal), however, have become too expensive for small-scale fish farmers in many developing countries due to competition with human and livestock needs. Hence, using local ingredients can increase farmers' incomes by reducing the cost of feeds and their reliance on imported feeds. It also has the potential to lessen the need for fishmeal and, thereby, decrease negative environmental impacts of aquaculture.

AquaFish collaborators began this line of research in 2009 and first directed their efforts towards leguminous tree leaf meals, such as *Moringa* leaf meals (MLM), as alternative protein sources for tilapia diets. Researchers chose these meals because they were locally available and had relatively high protein content, digestibility, and balanced chemical compositions. In the first stage of the study, AquaFish partners discovered that fish fed diets with up to 25% of soybean substituted with MLM had comparable growth rate and body size as fish fed soybean meal based diets. Researchers also determined that leaf meal-based diets were more economical than soybean based diets. In the second stage of the study, researchers soaked the *Moringa* leaves to reduce anti-nutritional factors and improve its palatability. Even after the leaves were soaked, total replacement of soybean meal with MLM negatively affected body weight gain and body composition of fish compared to fish fed soybean-based diets.

In response to the shortcomings of MLM as a primary protein source, AquaFish partners conducted another study to evaluate two invertebrates, housefly maggot meal (HFM) and earthworm meal (EWM), as protein sources in tilapia feed. Results suggested that feeds could include HFM or EWM up to 35% without impacting biological performance and inclusion of such an amount was most cost effective. Because of the initial success of feeds including HFM and EWM, AquaFish researchers are now attempting make HFM and EWM more accessible to small-scale farmers by developing simple and affordable techniques for mass production of housefly maggots and earthworms.

(Photo courtesy of AquaFish Innovation Lab)

Culture of earthworm meal.

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At first, small-scale fish farmers were not too keen on incorporating such unusual (and often slimy) ingredients into their feeds; hence, AquaFish researchers conducted workshops and trainings on alternative feeds. They shared their findings via eight different workshops, where nearly 200 stakeholders, including farmers, academics, government employees, and others were trained. On a larger scale, this line of research was communicated with the academic community through five presentations at international conferences and the MLM findings were disseminated through two peer-reviewed publications and one trade journal article. When experiments are complete, researchers hope to expand the impact of AquaFish research by scaling up this technology through partnerships with local and regional feed manufacturers. Stay tuned for the full report of this study and many other lines of AquaFish feeds research!

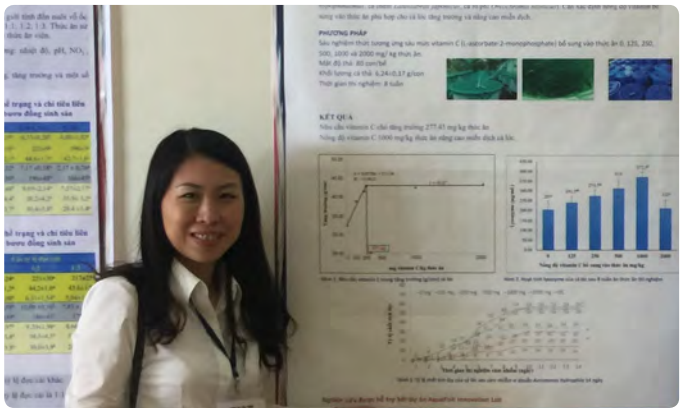
(Photo courtesy of AquaFish Innovation Lab)

Trainees overlooking fish culture tanks during AquaFish workshop.

AquaFish Student Corner

Graduate Student Profile: Khanh Nguyen Tuong

By Lindsay Carroll, AquaFish Innovation Lab



(Photo courtesy of Khanh Nguyen Tuong)

Khanh Nguyen Tuong, AquaFish student from Can Tho University, presenting a poster from her master's research evaluating the effects of supplementing snakehead feed with vitamin C.

Did you remember to take your vitamins today? Like us, fish require essential vitamins, minerals, and amino acids to maximize growth and overall health. Vitamin C supplementation, specifically, has several benefits for fish, such as increased growth and disease resistance and decreased likelihood of skeletal deformities.

For her Master's thesis, Vietnamese native, Khan Nguyen Tuong worked under the mentorship of AquaFish partners, Dr. Tran Thi Than Hien and Dr. Pham Minh Duc, at Can Tho University (CTU) in Vietnam, and additional collaborators at the Inland Fisheries Research and Development Institute in Cambodia, to determine the effects of supplementing snakehead feed with vitamin C.

Using laboratory and on-farm trials, Nguyen Tuong and the research team determined that growth rates and protein efficiency ratios were significantly greater in fish fed vitamin C feed compared to diets without additional vitamin C. Commercial scale, on-farm trials

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AquaFish Student Corner

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revealed that feed supplemented with 500 mg of vitamin C per kg of feed yielded ideal production costs and fish growth, a larger amount of vitamin C than originally thought sufficient (80-150 mg/kg).

In May 2017, Nguyen Tuong completed her thesis titled "Effects of vitamin C on growth performance and immune response of snakehead (*Channa striata*)," earning her Master's degree in Aquaculture from CTU. Nguyen Tuong is grateful for her degree and collaboration with AquaFish. "I learned how to manage an experiment and now have new knowledge I can [apply to] my job," said Nguyen Tuong.

Now, Nguyen Tuong is applying her aquaculture degree as a permanent staff member of the Extension Office located in the Thoai District of the An Giang Province. Being from the Thoai District, she is thrilled at the opportunity to help farmers of her province build their capacity and adopt sustainable aquaculture practices.

Graduate Student Profile: Diana Asero

By Lindsay Carroll, AquaFish Innovation Lab

Diana Asero, native of Serere, Soroti, Uganda, recently defended her Master's thesis, titled "The assessment of fish marketing in central Uganda," in December 2017. She first connected with AquaFish three years ago as she began her Master's degree in Agricultural and Applied Economics under the mentorship of AquaFish partner, Dr. Theodora Hyuha, at Makerere University.

Fish markets are made up of traders (e.g., wholesalers and retailers) and brokers, among other key players. Market performance depends on key players setting market prices, which then impact their profits, costs, and market margins (difference between what a buyer pays for a product and what the product is sold for). The goal of Asero's research was to investigate the individual components that contribute to market performance and "identify the factors affecting the market efficiency of traders," said Asero.

Through her assessment, Asero determined that price, fish form handled (e.g., fish fillet, whole fish, fresh, or frozen), and fish volumes handled as well as the trader's gender, age, and market experience all significantly impacted marketing efficiency. Her research revealed that fish trade, especially at the wholesale level, was dominated by males. "This was due to the fact that [wholesale level] demands more start-up funds compared to the retail level," said Asero. She also determined retail traders were more efficient and generated higher market margins, compared to wholesale retailers.

Asero is optimistic about the impact of her research. "The information generated from this research is vital to policy makers addressing the different challenges faced by fish traders in central Uganda. It will also help potential investors know where to invest their money along the fish marketing value chain," she said.

Asero was first attracted to aquaculture because she wanted to fill the knowledge void surrounding the social economics of aquaculture in Uganda. If funding permits, she hopes to embark on a PhD program abroad so that she can continue to gain experience to further address these challenges.

(Photo courtesy Diana Asero)

AquaFish Master's student, Diana Asero, presents poster about her research at 2017 AquaFish Regional meeting held in Uganda.

AquaFish Alumni Corner

Where Are They Now?: Sagiya Sharmin Suchana

By Lindsay Carroll, AquaFish Innovation Lab

"How do fish live in the water? What are the feeding habits of fish? How do different water quality parameters affect fish?" These questions that originally attracted Bangladesh native, Sagiya Sharmin Suchana, to study fisheries and aquaculture gradually transitioned into thoughtful objectives, including "How can I reduce fish production costs for small-scale farmers, especially in the remote areas of Bangladesh?"

To answer her questions and help address the challenges facing Bangladeshi aquaculture farmers, Suchana set her sights on a career in fisheries. In 2014, she completed her Bachelor's degree in Fisheries from Hajee Mohammed Danesh Science and Technology University in Dinajpur, Bangladesh. Then, in August 2016, with the support of AquaFish and mentorship of AquaFish research partner, Dr. Mst. Kaniz Fatema, she earned her Master's degree in Fisheries Management from Bangladesh Agricultural University.

Her thesis was titled, "Evaluation of production performance and potential economic and environmental benefits of reduced feed ration in tilapia (*Oreochromis niloticus*)-carp (Rui, *Labeo rohita* and Catla,*Catla catla*) polyculture systems." Simply stated, "my research mainly focus[ed] on how to [maximize] fish growth and [minimize] production costs while reducing feed rations in [tilapia-carp polyculture systems]," said Suchana.

(Photo courtesy Sagiya Sharmin Suchana)

Sagiya Sharmin Suchana (middle) measures tilapia alongside advisor and AquaFish partner, Dr. Mst Kaniz Fatema (left).

(Photo courtesy Sagiya Sharmin Suchana)

Sagiya Sharmin Suchana, AquaFish alumni from Bangladesh Agricultural University.

Polyculture, growing more than one species in the same system, has proven to be an environmentally friendly way to maximize use of the entire pond system. Carps are ideal species to use in polyculture because carp prefer to feed on the naturally occuring organisms (e.g., plankton and zooplankton) that are enhanced by pond fertilization, fish waste, and feed inputs. Previous AquaFish research that focused on tilapia-carp polyculture determined that farmers could reduce production costs and increase profits by cutting tilapia feed rations in half and boosting plankton growth for carp through pond fertilization.

With these previous findings in mind, Suchana helped investigate the impact of feed reductions on the production performance among different carp-tilapia polyculture (tilapia-Rui and tilapia-Catla) and mixed polyculture (tilapia-Rui-Catla) combinations. The study determined that tilapia-Catla polyculture resulted in the highest survival and growth rates of tilapia as well as the highest net returns and cost-benefit ratios compared

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to the other combinations. Considering these findings, she hopes farmers are able to increase their profits by adopting tilapia-Catla polyculture methods determined through AquaFish research.

For Suchana, her research was more than just science, it was an experience. "When I dropped feed into the ponds, the fish [came] together and sometimes jumped out of the water! [Seeing that] gave me a lot of joy," she said. She was also thrilled with "finding life in the mud," as she reflected on coming across benthos for the first time in her pond mud samples.

Now, Suchana works as a lecturer for the Department of Fisheries at the Institute of Applied Science and Technology, a private institute affiliated with Rajshahi University in Rangpur, Bangladesh. When asked about her future plans, she said, "I hope to possibly complete a PhD abroad with a similar research focus to my master's work."

Suchana's curious and analytical mind provided the initial spark that ignited her interest in fisheries and aquaculture. These qualities combined with her education, ambition, and passion to help others, will continue to fuel her to find ways to help reduce fish production costs for farmers and further conquer other aquaculture challenges in Bangladesh.

(Photo courtesy Sagiya Sharmin Suchana)

Sagiya Sharmin Suchana collects fish from experimental aquaculture pond at Bangladesh Agricultural University.

Notices of Publication

Notices of Publication announce recently published peer-reviewed work carried out with AquaFish support. To receive a full copy of a publication, please contact the author(s) directly.

Towards Assessing Gender Authorship in Aquaculture Publications (17-383)

Morgan Chow[1], Hillary Egna[2], and Jevin West[3]

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3. University of Washington, Seattle, Washington

While gender disparities are decreasing in some areas of academia, studies have shown that gender inequities in scholarly literature still persist. A review of more than eight million papers across disciplines found that men predominate in the first and last author positions and women are underrepresented in single-authored papers.

The present study applies the vetted methodology of assigning authorship gender in peer- reviewed literature, according to the U.S. Social Security Database of names, to the broad discipline of aquaculture in peer-reviewed journals in the complete JSTOR database archive, and compares these results to authorship by gender in the International Aquaculture Curated Database (IACD). The International Aquaculture Curated Database (IACD) is a compilation of over 500 peer-reviewed publications supported by four international aquaculture programs developed by Oregon State University researchers. Preliminary findings reveal that the percentage of women authors was similar to that for the JSTOR aquaculture journals subsample (13.8 %) and the journals in the IACD (15.7 %). Women, therefore, are not well represented in either database. The next steps for this work include comparing and contrasting the proportion of women authors in aquaculture journals to women working in the aquaculture discipline and to women graduates in the discipline. Learning how gender authorship has changed in the aquaculture discipline is a critical component for promoting gender equity in the academic discipline and broader field of aquaculture.

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This abstract was excerpted from the original paper, which was in the Gender in Aquaculture and Fisheries: Engendering Security in Fisheries and Aquaculture, Asian Fisheries Science Special Issue (2017), 30S: 129-141.

Microsatellite Markers Reveal Genetic Differentiation of Chinese Dojo Loach *Misgurnus anguillicaudatus* in the Yangtze River Basin (17-384)

Khalid Abbas[1], Zhou Xiaoyun[2], and Wang Weimin[2]

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2. Agricultural University, College of Fisheries, Huazhong, Wuhan, 430070, China

The fish fauna in the Yangtze-based riparian ecosystem has been imperiled largely due to genetic degradation of populations. Regular genetic monitoring of the fish populations is required for an effective management and conservation. The genetic structure of Dojo loach, *Misgurnus anguillicaudatus* was investigated in twelve populations originating from the Yangtze River basin by using thirteen microsatellite loci. The number of alleles per locus varied between 2 and 8 with an average of 4.6 alleles per locus. Overall, low-to-moderate level of genetic diversity was observed in the loach populations. Significant deviations from Hardy-Wienberg equilibrium were observed in about 50% of the total locus-population combination tests. The AMOVA indicated that most of the variance existed among the individuals (90.50%) rather than among populations within groups (9.03%). Significant differentiation was found among the samples from scattered habitats with different connections to the Yangtze River ($P<0.05$). The clustering of sample populations in UPGMA dendrogram followed their geographic distribution except for Zigui and Xiaogan which clustered against their geographical origin. The factors involved in genetic differentiation and shaping the existing patterns of population structure of the loach were discussed so as to provide guidelines for conservation strategies and management programs.

This abstract was excerpted from the original paper, which was in the Turkish Journal of Fisheries and Sciences (2017), 17(6):1167-1177.

Involving Women in Field-Testing of Periphyton Enhanced Aquaculture System for Nutrition Security (17-385)

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2. University of Michigan, Ann Arbor, MI 48109-1115, US
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An on-farm trial of carp polyculture was carried out with participation of women farmers from Sundardeep Women Fish Farmer's Cooperative (15 women farmers) in Chitwan District and Mishrit Fish Farmer's Cooperative (22 women farmers) in Nawalparasi District to field-test the enhancing effect of periphyton on use of feed and fish production. The trial was conducted for 8 months from April to December 2015. Women farmers stocked six carp species and two small indigenous species (SIS) to ponds. Women farmers were divided into two groups. One group fed their fish with dough of rice bran and mustard oil cake, while the other group installed bamboo substrates in their ponds and fed their fish with half the amount of the feed used by the first group. Women farmers netted and weighed fish monthly to check fish growth and calculate ration. Women farmers were provided with a book to record fish harvested for consumption or sale and fish mortality. Final harvest was done after 8 months of culture. The netted fish were counted, weighed, and returned to the pond as the farmers wanted to keep fish for their biggest festival "Maghi" in mid-January. In aggregate, 84 % of farmers consumed fish at home, and 41 % of farmers sold carps. The trial showed that culturing carps with SIS with 50 % feeding amount and with bamboo substrates in ponds resulted in a 22 % higher fish production as compared to the culture of carps with normal feeding. More interestingly, the gross margin of the half-fed periphyton enhanced carp polyculture was almost two times as much as that of the normal fed polyculture system. Women farmers also benefited socially as well as economically from the interactions within the cooperatives, which increased their self-confidence and developed leadership skills in some members.

This abstract is excerpted from the original paper, which was in the Gender in Aquaculture and Fisheries: Engendering Security in Fisheries and Aquaculture, Asian Fisheries Science Special Issue (2017), 30S: 265-275.

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Women in Riverbed Aquaculture for Livelihoods in Foothills of Nepal (17-386)

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Small-scale aquaculture is one of the options for improving household family nutrition and also supplements income for rural poor. Family nutrition depends on women as they prepare, cook and provide food for the family in most of the Nepalese communities. This short communication deals about the use of foot hill riverbed for aquaculture involving women in order to improve family nutrition and supplement income of an ethnic community. 90 household ponds were constructed on both sides of river flood plain in foothills of Nepal. Womens' groups participated in monthly technical training sessions along with fish farming activities. Ponds were stocked with grass carp (*Ctenopharyngodon idella* (Valenciennes 1844)), common carp (*Cyprinus carpio* (Linnaeus 1758)) and Nile tilapia (*Oreochromis niloticus* (Linnaeus 1758)). Local river species were allowed to enter and grow in ponds. Pond dikes were used for vegetable farming, grass cultivation, and pig farming. Though pond fish farming added extra work, ethnic women were able to produce significant amounts of fish, fruits and vegetables that supported family nutrition and was also a source of income.

This abstract was excerpted from the original paper, which was in the Gender in Aquaculture and Fisheries: Engendering Security in Fisheries and Aquaculture, Asian Fisheries Society Special Issue (2017), 30S: 327-332.

Improving the Livelihood for Marginalized Women's Households in Southwest Bangladesh through Aquaculture (17-387)

Shahroz Mahean Haque[1], Sattyananda Biswas Satu[2], Mojibar Rahman[1], Hillary Egna[3], Scott Salger[4], and Russell J. Borski[4]

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3. AquaFish Innovation Lab, Oregon State University, Corvallis, OR, US
4. Department of Biological Sciences, North Carolina State University, Raleigh, NC, US

Mud crab (*Scylla serrata* (Forsskål 1775)) fattening and culture is an emerging industry in Bangladesh that directly benefits households in the coastal region of Bangladesh. Currently, 37.8 % of crab fattening and culturing facilities are owned and operated by women whose households are generally poor. The study was conducted to promote the integration of tilapia (*Oreochromis niloticus* (Linnaeus 1758)) into mud crab culture, thus diversifying the crops and potentially improving household income and nutrition. First, a baseline survey of 150 mud crab farmers in the Satkhira, Khulna, and Bagerhat regions was conducted, focusing on household food consumption, dietary nutrition and earned incomes, plus household demographic and socio-economic information. The survey revealed that the majority of mud crab farmers are poorly educated (5 years average schooling) and consumed low dietary nutrients, particularly from animal protein sources. Second, tilapias were integrated into mud crab culture by 45 farmers, 15 from each surveyed region. 5 farmers from each region continued with the traditional mud crab fattening procedures and 10 were instructed in methods of mud crab and tilapia stocking and culture, using mixed sex tilapia for continuous breeding. 5 of the 10 farmers sold their tilapia to market while the other 5 kept the tilapia for direct household consumption. In both groups small tilapia were fed to mud crabs to reduce reliance on wildcaught trash fish as feed. Including tilapia in mud crab fattening and culture increased growth and production of mud crabs, albeit not to a level that differed significantly from the group where mud crab alone were produced. Adding tilapia into mud crab culture increased the nutrient-rich foods available for the farmer's households. A follow up survey found that the women and their household members improved their incomes and consumption of high quality protein. Overall, the integration of tilapia provides a more sustainable method for growing mud crab while also enhancing the livelihoods of farmers.

This abstract was excerpted from the original paper, which was in the Gender in Aquaculture and Fisheries: Engendering Security in Fisheries and Aquaculture, Asian Fisheries Society Special Issue (2017), 30S: 313-326.

Upcoming Meetings and Events

Aquaculture America
19-22 February 2018
Las Vegas, Nevada, US
https://www.was.org/meetings/

Oregon Chapter Annual Meeting
American Fisheries Society
13-16 March 2018
http://orafs.org/2018-annual-meeting/

Asian Pacific Aquaculture 2018
23-26 April 2018
Taipei, Taiwan
https://www.was.org/meetings/default.aspx?code=APA2018

AQUA 2018
25-29 August 2018
Montpellier, France
https://www.was.org/meetings/default.aspx?code=Aqua18

American Fisheries Society Annual Meeting
19-23 August 2018
Atlantic City, New Jersey, US
https://afsannualmeeting.fisheries.org/

International Summit on Fisheries and Aquaculture
13-14 August 2018
Amsterdam, Netherlands
http://scientificfederation.com/fisheries-aquaculture-2018/

9th International Conference on Fisheries and Aquaculture
17-19 September 2018
Vancouver, British Columbia, Canada
https://fisheries.conferenceseries.com/

GOAL 2018
25-27 September 2018
Guayaquil, Ecuador
https://www.aquaculturealliance.org/goal/

LAQUA 18
23-26 October 2018
Bogota, Columbia
https://www.was.org/meetings/default.aspx?code=lacqua18

AquaNews Update

As AquaFish Innovation Lab comes to an end soon, we would like to take this opportunity to announce that this winter issue of AquaNews will likely serve as the second to last edition of a 30+ year legacy. Be sure to keep an eye out for the last edition of AquaNews honoring AquaFish research, collaboration, and capacity building efforts over the years.

Get featured in AquaNews

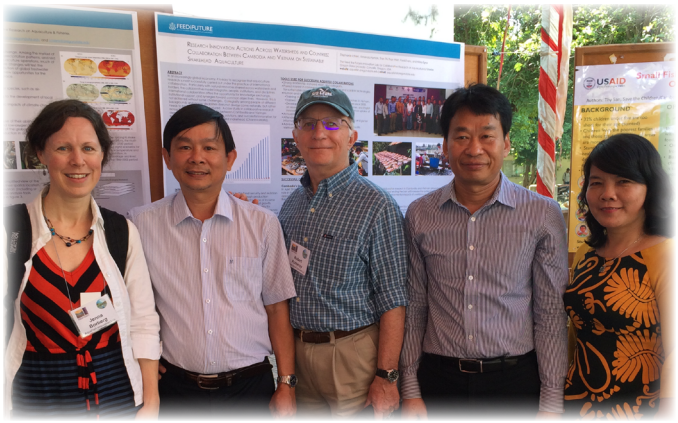
Are you a current or former AquaFish Innovation Lab-supported student? Are you an AquaFish alumni? Know someone who is? We'd like to hear from you for a possible feature on our Student Legacy webpage. Email aquafish@oregonstate.edu.

For more meeting and employment opportunities visit our Education and Employment Opportunities network database online, EdOpNet, at http://aquafishcrsp.oregonstate.edu/educational-employment-opportunities-network

Send us your story ideas and photos

Are you working on a currently funded AquaFish Innovation Lab project? Do you have story ideas or photos you want to send us? Email your story suggestions and photo submissions for consideration to aquafish@oregonstate.edu.

Parting Shot



(Photo credit Stephanie Ichien)

AquaFish shares research at inaugural International Sustainable Agricultural Intensification and Nutrition Conference in Cambodia in January 2018. From left to right: Jenna Borberg, Dr. Pham Minh Duc, Dr. Robert Pomeroy, Dr. Touch Bunthang, and Dr. Tran Thi Thanh Hien.

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AquaFish Innovation Lab and aquaculture publications can be accessed online at http://aquafishcrsp.oregonstate.edu/nop

AquaNews is available on-line at http://aquafishcrsp.oregonstate.edu/aquanews.

Your comments, stories, student profiles, and photos are always welcome! Send information to aquafish@oregonstate.edu (please include "AquaNews" in the subject line).

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