



AQUAFISH RESEARCH ON FEEDS CONTRIBUTES TO LIFTING OF CAMBODIAN SNAKEHEAD BAN, OPENS DOOR TO ECONOMIC OPPORTUNITIES

By **Susannah L. Bodman and
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The ban on snakehead (*Channa striata*) farming in Cambodia originally set in place in September of 2004 was lifted in April of 2016. AquaFish-supported research played a critical role by informing the design and implementation of a successful and sustainable snakehead aquaculture policy.

Fisheries of the Lower Mekong Basin provide a means to create food security and nutrition for 60 million people in Cambodia and Vietnam. While aquaculture of snakehead in Vietnam was increasing in popularity because of its high market value, snakehead farming was banned in neighboring Cambodia.

Traditional methods of snakehead culture involved



(Photo courtesy of AquaFish Innovation Lab)

A farmer poses next to a bag of alternative protein feed developed by AquaFish researchers.

catching juvenile striped snakehead from the wild, holding them in ponds or cages, and feeding them wild-caught, small, low-value, freshwater fish. Therefore, the goal of the ban was to

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Rupa Lake Cooperative

Local cooperative in Nepal balances economic and environmental benefits to positively impact the livelihood of local families.

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Africa Regional Meeting

AquaFish partners in Africa provide updates on research progress and engage with local aquaculture farmers in Uganda.

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alleviate pressure on the wild populations that were being harvested for snakehead feed and to reduce unsustainable wild seed collection practices.

Snakehead contribute to 70% of total aquaculture production and generate 10-times more profit compared to other fish species in Cambodia. After the ban was put in place, fisherman began to illegally import snakehead from neighboring countries and continued to illegally harvest and export small-sized fish for snakehead feeds used outside Cambodia. Fishing pressure also increased on wild snakehead populations as fisherman began to use electro-shockers, a method used to stun fish, to catch snakehead illegally.

Since the ban, AquaFish Innovation Lab researchers — at the Inland Fisheries Research and Development Institute (IFReDI) in Cambodia, Can Tho University in Vietnam, and the University of Connecticut–Avery Point, University of Rhode Island, and Oregon State University in the US — have been working in the region to develop technologies and strategies to create a sustainable snakehead aquaculture program that can meet consumer demand.

AquaFish-supported research in Cambodia and Vietnam was aimed to reduce the reliance on small-sized fish without decreasing growth performance and marketability of



(Photo credit Peg Herring)

Small-sized, low-value fish traditionally used to feed snakehead prior to the development of alternative protein by AquaFish researchers.

GOINGS-ON IN THE POND



AQUAFISH DIRECTOR AND STAFF PUBLISH BOOK CHAPTER

The inclusion and participation of women in small-scale aquaculture sectors is often underestimated and undervalued. However, as natural hazards increase the vulnerability of coastal aquaculture communities, recent research showed the integration of women during the implementation of disaster management plans helps reduce overall disaster risk. Research assessed gender integration as a result of disaster risk reduction legislation implemented in the Philippines after two major typhoons hit the area in 2013 and 2014. Read the full abstract of the book chapter titled, "Gender Dimensions in Disaster Management: Implications for Coastal Aquaculture and Fishing Communities in the Philippines" in the Notice of Publication on page 14 of this issue.

AQUAFISH RESEARCHERS PUBLISH ARTICLE IN WORLD AQUACULTURE MAGAZINE

Snakehead fisheries are a valuable source of income and nutrition for many households of the Lower Mekong Basin (LMB) located in Cambodia and Vietnam. Both climate and non-climate-related changes, including rising temperatures and altered rain patterns, development of hydropower dams, flooding, and changes to sediment run-off patterns are impacting aquaculture production in the LMB. AquaFish researchers explored the impacts of these changes from production to consumption to better inform adaptation strategies for the production process moving forward. Read more on these efforts in the recently published article titled, "Assessing the Impacts of Climate Change on Snakehead Fish Value Chains in the Lower Mekong Basin of Cambodia and Vietnam," in the [December 2016 Issue of World Aquaculture Magazine](#).

snakehead. AquaFish research specifically addressed the domestication of snakehead, the creation of alternative protein commercial feeds, and the development of methods for the weaning and grow-out of hatchery-reared snakehead on formulated feeds.

A key tipping point occurred when Cambodia's Fisheries Administration (FiA) sought information from AquaFish researchers. So Nam, an AquaFish researcher from IFReDI reflected, "they [FiA] asked for the whole

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package." Specifically, FiA was interested in learning more about AquaFish's research on snakehead culture techniques as well as their analysis on the overall economic efficiency of replacing the freshwater, low-value fish with formulated feed.

AquaFish researchers in Vietnam first developed a pelleted snakehead feed that contained plant protein, a far more sustainable ingredient than typical fishmeal. They found that snakehead feed could contain up to 40% soy protein without affecting fish growth of domesticated strains of snakehead or economic efficiency.

Once the feed was successfully adopted by feed mills and farmers in Vietnam, AquaFish researchers compared the weaning and grow-out performance of wild, indigenous snakehead in Cambodia to that of domesticated snakehead from Vietnamese hatcheries using pelleted diets that contained a combination of soybean and fish meal. The Vietnamese hatchery fish showed a higher growth rate than that of wild Cambodian snakehead.

Cambodia's FiA ultimately relied on information from AquaFish researchers regarding their investigations of snakehead domestication and breeding, weaning, and grow-out when considering a change to Cambodia's snakehead policy.

Success in ending the ban not only opens the door for improved economic opportunities and better nutrition and food security for Cambodians while beginning to alleviate the environmental impacts of overfishing in the Lower Mekong Basin. To quantify these efforts, researchers are conducting a survey throughout the nation on food security and household nutrition, with particular focus on the health of women and children.

Outreach to spread information about the technology has already begun in the form of trainings about sustainable, small-scale snakehead culture for farmers in the Lower Mekong. Today, more than 90 percent of

snakehead farmers use a pelleted feed that combines fish and soybean meals. Future outreach efforts will continue to reach Cambodian fish farmers and government fisheries officers.

The lifting of the ban was much needed, as "the ban lift leads to increased household income of snakehead farmers," said Nam. "The ban's lifting also has positive impacts on food security and nutrition of snakehead farmers," he said.



THE RUPA LAKE COOPERATIVE: PROVIDING JOBS AND MAXIMIZING NATURAL RESOURCE USE IN NEPAL

By Madhav Shrestha¹, Jay Dev Bista¹, and James Diana²

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(Photo courtesy James Diana)

Rupa Lake is home to the cooperative. Note the heavily forested watershed also managed by the cooperative.

The Rupa Lake Cooperative is an organization in Nepal focused on improving the fisheries in a series of reservoirs but is doing so in quite a unique fashion. The cooperative began more than 15 years ago with an original focus on stocking carps in lakes to improve harvest.

Cooperation between the Nepal Agriculture Research Council at its Fishery Research Station in Begnas, the Agriculture and Forestry University, and the cooperative has been instrumental in revitalizing the fishery,

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watershed, and livelihoods of people in the surrounding area. Dr. Jay Dev Bista, AquaFish researcher from Agriculture and Forestry University in Nepal (previously with the Fisheries Research Center located in Pokhara, Nepal), as well as several other AquaFish partners from Nepal, serve as technical advisors for the cooperative.

From the initial focus of stocking carps provided by the Begnas Lab, the cooperative expanded to include watershed management as a means to improve the lake ecosystem and evolved into a strong program earning money for its members and improving the quality of life for all people living in the area. The development of the cooperative is unique and promising for the future of watershed management in developing countries.

Among developing nations, Nepal remains quite a poor country, with typical incomes for residents at about \$1 per day. Most people, when faced with this level of poverty in their lives, might focus on increasing their income at the expense of natural resource management. However, the cooperative reversed this trend by both increasing the income of members and improving the natural resources on which their income is based.

The cooperative accomplished this by recognizing early on that the fisheries pursued by its members were dependent on high



(Photo courtesy James Diana)

Rupa Lake Cooperative leaders and AquaFish partners in Nepal visited a site overlooking the lake near a wireless internet tower provided to local residents by the cooperative.

water quality and ecosystem function in the lakes they fished. They therefore worked to improve water quality by addressing problems in the watershed, which ultimately paid off in terms of better fish production and higher yield, income, and quality of life. While many people have these goals in the work they do, it is rare to see such goals so prominently and successfully displayed as in this cooperative.

The lakes that are involved in the cooperative include Rupa Lake (135 hectares/nearly 1900 acres) and five other smaller lakes in the middle hills region of Nepal near Pokhara, located at an elevation of about 600 meters (nearly 2000 feet). The lakes are currently reservoirs, although they were smaller lakes in this area before the rivers were dammed to retain more water. Fisheries serve as a traditional employment opportunity in the area, in addition to forestry and agriculture in the watershed. Human habitation and population growth increased the nutrient run-off entering the lake. As a result, the lakes became eutrophic, or rich in nutrients, causing poor water quality and large coverage by aquatic plants, including water hyacinth. The fish population also became degraded, and harvest was limited as a result of these stressors.

The original cooperative was formed in 2001, initially to stock fish in the reservoir. Carps were harvested at about 1 kilogram (2.2 pounds) in size, mainly by gillnets deployed from small boats. Cooperative leadership initiated an education program to inform local residents about the value of working together to improve the quality of the lake and its resources. Families paid about 5,000 Nepal Rupees (about US\$47, or 1.5 months of average income per capita) to join the cooperative. A constitution was developed (see <http://goo.gl/FoxAmH>), and about 720 families are members today. Project funding was used to hire around 20 people to fish and manage the lake, and money earned was distributed to the cooperative and to member families.

One key to economic development of the lakes in the region was setting fishing limits to reduce dramatic overfishing. Cooperative

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income was invested back into stocking fish; improving conditions in the watershed, particularly reforesting slopes nearby; and improving the quality of life in the region through improved basic services, access to technology (for example, they have established wireless internet access in the region), and improved education.

The initiative has been dramatically successful. The annual harvest is about 30–50 metric tonnes (66,000 – 110,000 pounds) and has remained relatively stable over time. Member families are earning about 17,000 Nepal Rupees (NR) annually per household from their shares of cooperative profits.

The lake's water quality has also improved, and coverage of aquatic plants has diminished, as growth is being maintained by species that consume the plants, such as grass carp. Initially, the cooperative hired local people to harvest hyacinth from the lake (300 NR per kilogram of hyacinth collected), which not only caused a rapid reduction in plant coverage, but generated local employment. "The lake is clear now" said Bista. "Before the cooperative the lake was full of pollutants and excess nutrients," he said.

In addition, six other cooperatives have developed in the region, including groups for beekeepers and goat farmers. In all cases, these cooperatives strive to enhance watershed conservation in the area as well as share profits from activities among members.

Meanwhile, the fishing cooperative also works to restore biodiversity in Rupa Lake. To do so, cooperative members interact closely with the Begnas Lab. The lab includes a hatchery system producing not only several carp species for stocking but is also a site for developing culture systems for native species.

The laboratory also serves as the home site for AquaFish-supported work, which focuses on the development of culture techniques for sahar, a native species pinpointed by researchers for both food-fish production and restocking value. "We have been producing

sahar at our site in Pokhara for stocking in Rupa Lake, and have also been working with [the cooperative] to improve their fishing techniques," said Jim Diana, AquaFish researcher from University of Michigan.

Much of Rupa Lake is shallow (less than 1 meter/3.3 feet) because of earlier problems with sedimentation, making it hard to harvest fish with gillnets. Gillnets can also cause damage to smaller fish being released and to the native species the cooperative is intending to restore. Possibilities being tested to address these issues include using small-sized trapnets, lift nets, and cast nets, but much development is needed to apply these methods to the lakes in the cooperative.

The fisheries cooperative has shown dramatic success both ecologically and economically, which is critical given the rarity of such organizations in developing countries. As an important part of the process, cooperative members have spent considerable time sharing the results of their work to generate additional support and interest from others for future collaborations and partnerships.

The cooperative serves as a model for Nepal and has potential to serve as a model for other countries," said Bista. Word is spreading of its accomplishments. "The [Nepalese] government recognizes the success and the cooperative model has now been used in southern Nepal," he said.



(Photo courtesy James Diana)

View of Rupa Lake, located in Nepal, showing the agricultural development near the lakeshore.



AQUAFISH PARTNERS IN AFRICA SHARE LESSONS LEARNED

By Lindsay Carroll, AquaFish Innovation Lab



(Photos courtesy of AquaFish Innovation Lab)

AquaFish director shares manuals on pond and soil management (upper-left); AquaFish partners dissect a lungfish with students from the National Fisheries Resources Research Institute and Makerere University (upper-right) and travel to local aquaculture farms (lower left and right).

In January 2017, AquaFish partners in Africa (from Ghana, Kenya, Tanzania, and Uganda) gathered in Kampala, Uganda, to share challenges and lessons learned and provide updates on research, capacity building, gender integration, and outreach efforts.

The process of finding local, cost-effective, alternative feeds was a recurring topic of discussion. Feed costs comprise 50-80% of all aquaculture production costs, which is why feeds research has served as one of the focal areas of AquaFish research for nearly a decade. Researchers are working to find alternative feed ingredients and determine reduced feeding strategies in order to improve production efficiencies.

To honor the many years of commitment to investigating feeds, AquaFish partners discussed a plan to assess the breadth and depth of AquaFish feeds research across program countries. Collectively, the group will synthesize this information to produce a report that highlights the most successful feed ingredients and strategies and the outcomes and impacts of that research. "The goal is to not only capture successes, but inform the direction of future feeds research," said Jenna Borberg of the AquaFish Management Team.

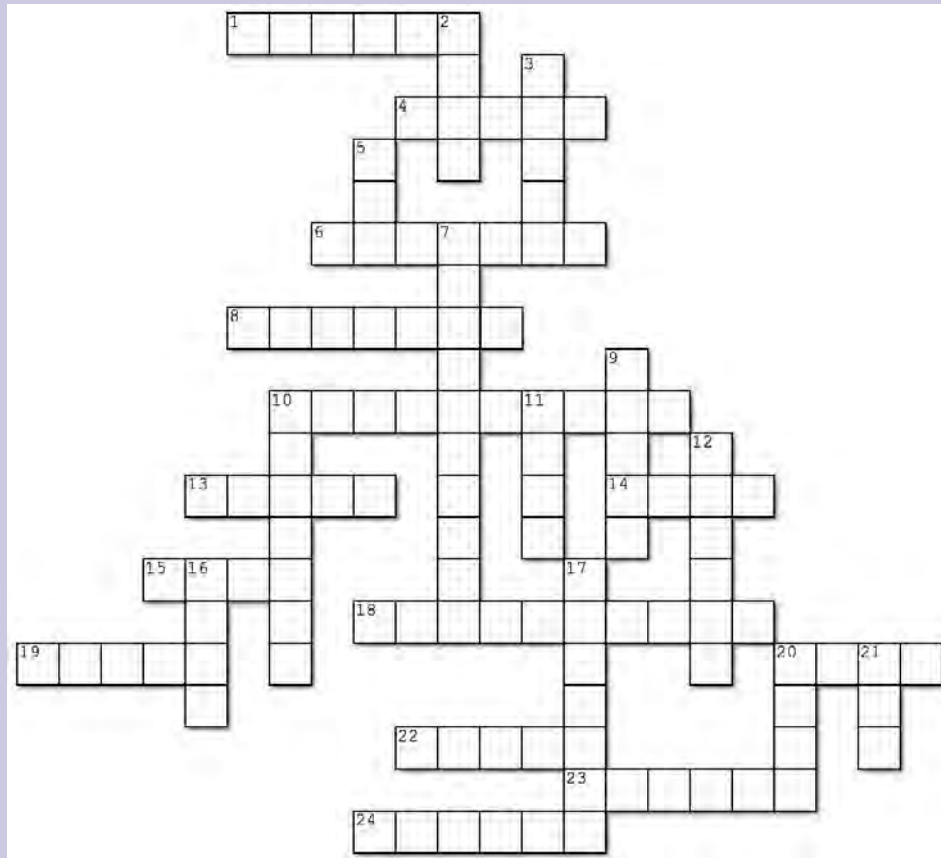
AquaFish regional partners also had the opportunity to tour local fish farm facilities to understand the state of aquaculture in Uganda and the growing capacity of the industry. The visits resulted in productive discussions, allowing AquaFish's African regional partners to share on the ground experiences in aquaculture management with local farmers. Simultaneously, the farmers were able to gain a greater understanding of feed types and costs and compare prices of fish sold in other locations.

Partners continued discussions about best practices for disseminating research and building local skills and knowledge. It is a high priority to ensure that AquaFish-supported research and technologies are transferred to host country researchers, extension agents, farmers, industry personnel, managers, and policy makers. Building individual, community, and institutional capacity is also important so that host country partners can establish and implement new lines of research once AquaFish funding has ended.



PONDERINGS ... AQUAFISH'S FIRST EVER CROSSWORD PUZZLE

Use the Across and Down clues to fill in the puzzle below.
Use the clickable hints to guide you to a previous Aquanews issue containing the answer.
*Indicates answer is within this current issue



ACROSS

1. LMB stands for Lower ____ Basin*
4. Country of origin - Rupa Lake Cooperative*
6. CRSP stands for Collaborative Research ____ Program
8. AquaFish Global Project Theme: Enhanced Trade Opportunities for Global ____ Markets
10. System used by Josiah Ani-Sabwa for his PhD research where plants are farmed alongside fish ([hint](#))
13. University in Ghana where fish farms were awarded for best aquaculture management practices (abbr. [hint](#))
14. One of the major indian carps identified as a delicacy in Nepal, Bangladesh, and other countries
15. Name given to oyster life stage once the larvae attaches to a hard surface to grow
18. A juvenile fish that has developed scales and working fins but has not reached full growth or sexual maturity
19. SIS stands for ____ Indigenous Species ([hint](#))
20. Leader of the Feed the Future Initiative, USAID's Bureau for ____ Security
22. VCA stands for ____ Chain Analysis ([hint](#))
23. IFRaDI stands for ____ Fisheries Research and Development Institute
24. One of the five AquaFish US Project Universities and home of Aubie the Tiger

DOWN

2. This type of farming involves building dikes in rice fields to create freshwater ponds to stock fish
3. Native fish AquaFish researchers are producing to help stock Rupa Lake and also culture alongside tilapia in Nepal*
5. University that offered the first Bachelor's of Science degree in Nepal (abbr.)*
7. Mixture of algae and microbes eaten by many fish that also help clear water of pollutants*
9. Food Consumption ____ used by Akua Akuffo to compare nutrition quality and food security of Ghana households*
10. Aquaculture is the farming of ____ life
11. Number of countries AquaFish works in currently
12. Genus of the striped snakehead fish*
16. Culture of multiple species at the same time, known as ____ culture, is being used to improve fish production*
17. The essential nutrient James Bundi Mugo altered in his fish feed experiments in an effort to reduce cost of fish meal to farmers ([hint](#))
20. AquaFish research on formulated ____ helped lift the snakehead ban in Cambodia*
21. University of AquaFish Innovation Lab Management

THE ANSWER KEY WILL BE POSTED ON AQUAFISH SOCIAL MEDIA BY 24 MARCH

AQUACULTURE COMMUNITY GATHERS TO SHARE RESEARCH RESULTS

By Briana Goodwin, AquaFish Innovation Lab

AquaFish partners of current and past projects joined over 2,500 aquaculture professionals in San Antonio, Texas, in February for the World Aquaculture Society's Aquaculture America Conference. AquaFish partners presented in seven sessions on a variety of topics including women in aquaculture, fish feeds, and water quality.

Regina Edziye, an AquaFish researcher at Kwame Nkrumah University of Science & Technology in Ghana, presented on locally sourced protein-alternatives for use in fish feeds. This research, which aimed to decrease costs and increase profits, identified several oilseeds grown in Ghana that show promise for use in feeds.



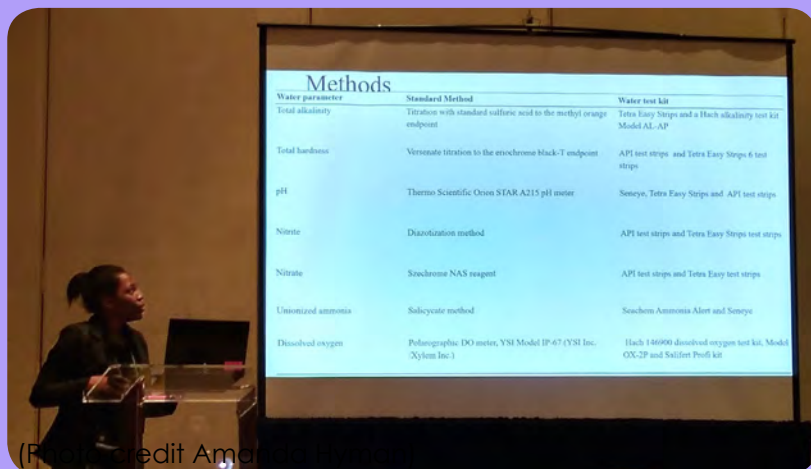
(Photo credit Briana Goodwin)

Regina Edziye from Kwame Nkrumah University presenting on feeds research in Ghana.

Kwamena Quagrainie, AquaFish researcher at Purdue University, presented on work in Ghana that is developing a cell phone-based system to provide fish farmers a direct link to market information. The system provides information via text and voice, making it accessible for illiterate users.

In addition to oral presentations, the AquaFish Management Team presented five posters on the AquaFish research portfolio. Bill Mancini with Fisheries Technology Associates Inc. tweeted about our women and youth in aquaculture poster, "Inclusion and gender parity in aquaculture is a must. Great poster!"

The Conference provided a great opportunity to share research results, learn from others, and expand the AquaFish network. Hearing about innovative ideas and promising lines of research left attendees inspired, energized, and further committed to addressing global aquaculture challenges.



(Photo credit Amanda Dwyer)

AquaFish student, Shamim Naigaga from Auburn University, compared several water quality test kits to laboratory test results and determined that test kits can serve as useful tools for farmers when making pond management decisions. More information on her methods and results can be found in her recent publication in the [Journal of World Aquaculture](#).

AQUAFISH STUDENT CORNER

GRADUATE STUDENT PROFILE: AKUA AKUFFO

By Lindsay Carroll, AquaFish Innovation Lab



(Photo courtesy of Akua Akuffo)

Akua Akuffo, a PhD student at Purdue University in the US, investigating the impacts of fish farm participation on household food security and nutrition in Ghana.

Fish serve as an important source of protein and macronutrients for many rural households across the world. Studying the nutritional content of fish species is important for addressing food security issues in many countries, particularly where fish is the most affordable source of protein.

Akua Akuffo, an AquaFish-supported PhD student at Purdue University under the advisory of AquaFish researcher Dr. Kwamena Quagraine, addresses those very themes through her research projects in Ghana and Tanzania.

One of Akuffo's projects evaluates the impact fish farming has on household nutrition and food security in Ghana. Akuffo and her collaborators used a food consumption score (FCS) because it is the most common metric used in other studies to measure nutritional quality and food security of households.

The FCS considers three parameters, including diet diversity, frequency of food group

consumption, and the relative importance or nutritional value of food groups consumed. Food groups consist of foods that have similar nutritional or caloric content. In the context of Akuffo's research, food groups include main staples (e.g., maize, rice, pasta, potatoes), pulses (e.g., beans, peas, nuts), vegetables, fruits, meat and fish, milk, sugars, oils, and condiments. Diet diversity relates to the number of different food groups consumed, while food frequency refers to the total number of days a food group is consumed during a time period.

Taken a step further, each of the food groups differ in nutritional value and, therefore, differ in relative dietary importance. Foods of the highest nutritional value are meat and fish and



(Photo courtesy of Akua Akuffo)

Data collection of a household mother while in Kumasi, Ghana during the summer of 2014.

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milk groups, while the oil and sugar groups rank the lowest.

Overall, Akuffo determined that fish farming in Ghana does improve FCSs. The improvement is "a result of the ability to purchase [a] variety of foods and also consume fish from [their] own pond," said Akuffo. The households are also able to use the income generated from fish farming to purchase and consume more diverse food groups.

Social and economic influences, including area (size of pond), age, household income, wealth index, mother's education, and household size on the FCS were also considered. Akuffo said that her results "indicated that the FCS is positively affected by household income, mother's education, and area of fish farming."



(Photo courtesy of Akua Akuffo)

Data collection of a household mother while in Kumasi, Ghana during the summer of 2014.

Akuffo is hopeful and optimistic of the impact of her research, as she stated, "I hope this research will further emphasize the importance of fish farming as a tool for poverty and food insecurity alleviation in Ghana."

Understanding the impact of fish farming on nutrition and food security in Ghana is only one of three research studies associated with Akuffo's PhD. Her other research studies include 1) determining the influences of market price and household income on the demand or decisions to purchase fish among Ghanaian households, and 2) investigating how current community infrastructure in Tanzania impacts accessibility and household consumption of seafood.

Akuffo is planning to publish the results of all three of her research studies. She has already presented her work at World Aquaculture Society (WAS) 2015 held in New Orleans, Louisiana, US and WAS 2016 held in Las Vegas, Nevada, US. In the near future, she plans to present her research at WAS 2017 in Cape Town, South Africa in June.

One of her most memorable experiences was participating in data collection in Ghana in 2014. "The fish farmers and their ponds were exceptionally wonderful and captivating. I have had the opportunity to learn more about the importance of fish and the fight against food and nutrition insecurity," she said.

Akuffo expects to graduate from Purdue University this year. When considering future plans after her degree, she said, "I plan to work as a nutrition economist with the World Food Program or any organization working in developing countries to alleviate poverty and improve food security."



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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 future feature in AquaNews. Email aquafish@oregonstate.edu.

AQUAFISH ALUMNI CORNER

WHERE ARE THEY NOW?

KAMALA GHARTI

By Lindsay Carroll, AquaFish Innovation Lab



(Photo courtesy of Kamala Gharti)

AquaFish-supported alumni and current AquaFish collaborator, Kamala Gharti, from Nepal.

As a Nepalese woman from Chitwan, Nepal, Kamala Gharti is very accustomed to traditional aquaculture and fisheries practices. "Growing up in a community where aquaculture and indigenous fish harvesting is the means of livelihood, I became attracted to the subject and hoped to make tangible change to traditional practices," she said.

Inspiration turned to action, as she has worked to address aquaculture challenges facing Nepal for many years. Gharti originally connected with AquaFish ten years ago when she began her Master's degree in Aquaculture, under the guidance of Dr. Sunila Rai. She earned her degree from what was then the Institute of Agriculture and Animal Science, Tribhuvan University (now known as Agriculture and Forestry University (AFU)).

For her Master's research, Gharti investigated alternative ways to culture Nile tilapia (*Oreochromis niloticus*) to maximize

production. Nepalese Nile tilapia culture is traditionally mixed-sex, where males and females are raised together. However, Nile tilapia reproduce quickly and mixed-sex culture often leads to the production of too many fish, otherwise known as overproduction. The overproduction of fish can cause reduced growth rates and undersized fish for the market.

To address these challenges, Gharti and her collaborators investigated the use of polyculture, or the cultivation of multiple species at the same time, to help manage the reproduction rates of tilapia. Her research explored culturing sahar (*Tor putitora*) alongside tilapia. Sahar are an economically important local fish and also have predatory habits that would help control excessive tilapia recruitment.

Gharti assessed different stocking ratios, or the proportion of fish, per pond of sahar to tilapia that would keep tilapia recruitment in check and maximize production. Results indicated that stocking one sahar for every 16 tilapia generated the best overall growth performance of both the tilapia and sahar.

One of Gharti's fondest memories during her Master's research was when she connected local farmers to her research. She said, "they were not convinced with my ideas and were hesitant to support my study. But, [once I presented] them with my results, they were completely surprised."

After completing her master's degree, Gharti was offered a position as a Technical Officer with the Nepal Agriculture Council (NARC). Within a year, she was offered a Scientist position at NARC where she worked for 5.5 years. Now, Gharti returned to her roots and serves as an Assistant Professor within the Department of Aquaculture and Fisheries at AFU.

At AFU, Gharti is able to build her partnerships as she now serves as a researcher on a

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current AquaFish project working to enhance periphyton in carp polyculture systems. Periphyton is a mixture of algae and microbes that live on surfaces within aquaculture ponds and has proven to be advantageous in aquaculture. Periphyton improves overall pond water quality by providing oxygen and removing excess nutrients. Using periphyton in pond culture also reduces feed costs for farmers because it serves as a food source for carp and many other pond culture species.

Gharti and her collaborators at AFU hope to determine suitable surfaces on which the periphyton can grow that will increase overall production within carp polyculture systems. Previous research investigated the use of bamboo rafts to increase surface area available for periphyton. However, trials revealed that while periphyton enhanced overall carp production, farmers reported that the bamboo raft systems became obstructive during fish harvest.

Therefore, the focus of the next phase of research is to meet with local farmers through a series of workshops to determine the most suitable alternatives. Once feedback is obtained, Gharti and her collaborators plan to field-test the proposed surfaces to determine the most appropriate option that maximizes periphyton growth while minimizing disturbance to farmers.

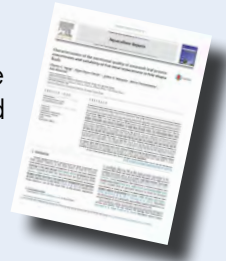
Gharti attributes a lot of her successes to her connection with AquaFish. "My journey after graduation is mainly due to the motivation, confidence, and insights I [gained] during my time as a student with AquaFish," she said.

It is clear that Gharti is making "tangible change to traditional practices" of aquaculture through her contributions to Nile tilapia and carp polyculture development. Gharti continues to build upon her education and apply her knowledge on the ground in Nepal where farmers need it the most. Additionally, as an Assistant Professor at AFU, she is able to serve as an example and inspiration to other students early in their careers.



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.



Assessing the reliability of water-test kits for use in pond aquaculture (16-365)

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Water-analysis kits are useful for practical aquaculture only if they provide equivalent decision-making as compared to standard water-analysis methods. This study used weighted Cohen's kappa (κ) statistics to compare management decisions made by farmers who used water-analysis kits (e.g., Seneye slide kit, Tetra EasyStrips, API test strips, Seachem Ammonia Alert, Salifert Pro test kit, and Hach dissolved oxygen (DO) and alkalinity kit) and decisions made by those who used standard methods. The decisions made by farmers were similar for water-analysis kits and standard methods, except for Tetra and API test strips, when measuring nitrate concentrations. The highest conformity between the two methods (κ -value = 1.0, $P < 0.0001$) was obtained with the Hach and Salifert Pro test kits (for measuring DO) and the API test strip (for measuring total hardness). The rapid, simple measurements by the kits appear suitable for use by farmers if they are properly maintained and manufacturer's instructions are followed.

This abstract was excerpted from the original paper, which was published in the [Journal of World Aquaculture](https://doi.org/10.1111/jwas.12377) (2016) DOI: 10.1111/jwas.12377.

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Monitoring the effects of aquaculture effluents on benthic macroinvertebrate populations and functional feeding responses in a tropical highland headwater stream (Kenya) (16-366)

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Intensification of aquaculture may result in more fish culture waste being discharged into adjacent rivers and streams. Due to composition of such wastes, ecological conditions in waterbodies may be adversely affected. We determined the ecological consequences of freshwater land-based Tilapia farms on headwater streams using macroinvertebrate community attributes and functional feeding response in an upstream tributaries of a highland stream in Kenya. Nine aquaculture sites adjacent to tributaries of three headwater streams with different fish production volumes were sampled and monitored for macroinvertebrate abundance, richness, composition of Ephemeroptera, Plecoptera and Trichoptera, Oligochaetes and Chironomids (percentage Oligochaetes and Chironomids), species diversity as well as the functional feeding group responses. The total abundance of benthic macroinvertebrate consistently increased near discharge points and immediately downstream of the effluent outlets near the aquaculture farms. We observed positive correlations between macroinvertebrate attributes (except Ephemeroptera, Plecoptera and Trichoptera) with fish production at aquaculture facilities adjacent to the tributaries of the headwater streams. The proportion of Oligochaetes and Chironomids (percentage Oligochaetes and Chironomids) increased while that of Ephemeroptera, Plecoptera and Trichoptera at discharge points and downstream of the farms decreased. Also, relative abundance of scrapers and shredders

decreased significantly, while significant increase of abundance was observed for deposit feeders, filter feeders and parasites with low predator population at discharge and downstream points. These consistent patterns indicated changes in ecosystem integrity and functioning, due to aquaculture effluents with particulate organic matter from fish food-derived wastes becoming a central source of energy in river benthic food webs.

This abstract was excerpted from the original paper, which was published in [Aquatic Ecosystem Health & Management \(2016\) 19\(4\): 431-440](#).

Growth, yields and economic benefit of Nile tilapia (*Oreochromis niloticus*) fed diets formulated from local ingredients in cages (16-367)

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Small-scale aquaculture in Africa is limited by cost of protein ingredient in fish feeds, which requires continuous research in ways of improving protein ingredients. We evaluated the suitability of replacing fishmeal with rice bran alone or rice bran in combination with atyid shrimp (*Caridina nilotica*) on growth performance and economic benefits of Nile tilapia (*Oreochromis niloticus*) cultured in cages suspended in static ponds. The best growth performance and feed conversion ratio (FCR) occurred in fish fed fishmeal followed by those fed a combination of rice bran and *C. nilotica*, while rice bran alone resulted in lowest fish growth performance. The best economic benefit was obtained from fish fed a combination of rice bran and *C. nilotica*. We therefore demonstrate that it is possible to replace expensive fishmeal in the diet of *O. niloticus* using combination of cheaper rice bran and *C. nilotica* without compromising economic benefits for the small-scale aquaculturists.

This abstract was excerpted from the original paper, which was published in the [International Journal of Fisheries and Aquatic Studies 2016; 4\(6\): 191-195](#).

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Gender Dimensions in Disaster Management: Implications for Coastal Aquaculture and Fishing Communities in the Philippines (16-368)

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Women are critical to aquaculture and small-scale fisheries sectors, despite the lack of recognition and access to resources. In the Philippines, the status of women has improved over the last few decades. However, gender issues during disasters still emerge. In 2009, the Asia-Pacific Economic Cooperation (APEC) published a study that indicated a high level of awareness of the importance of gender integration for disaster risk reduction (DRR) in the Philippines, yet gaps remain during disaster plan implementation. This research builds on that study by assessing gender integration in disaster management in fishing and aquaculture communities since recent DRR legislation (2010) and two major typhoons (2013 and 2014). Results reveal that important steps are being taken to integrate gender at the disaster risk reduction and management (DRRM) programmatic level, yet gaps remain at the community level. Addressing these shortcomings and underlying perceptions of gender in disaster management will foster more resilient fishing and aquaculture communities in the Philippines and nations worldwide.

This abstract was excerpted from the original publication, a chapter published in the Michele Companion and Miriam S. Chaiken (Editors), [*Response to Disasters and Climate Change: Understanding Vulnerability and Fostering Resilience*](#). Taylor and Francis Group, Florida, pp. 159-172.

Water quality and red bloom algae of fish ponds in three different regions of Nepal (16-369)

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Present study determines the causes and seasonal variation of red bloom in fish ponds of Eastern, Western and Central regions of Nepal. Monthly monitoring of water quality and phytoplankton was carried out for one year. Water parameters such as NH₃-N, total phosphorus, total Kjeldahl nitrogen (TKN), total dissolved solids (TDS) and conductivity were significantly higher ($p < 0.05$) in red bloom fishponds than non-red bloom fishponds. The total density of euglenophytes in red-bloom fishponds was significantly higher ($P < 0.05$) (1970 ± 260 cells L⁻¹) than non-red bloom fishponds (410 ± 30 cells L⁻¹). Euglenophyte density varied seasonally and significantly lower in spring season (1250 ± 220 cells L⁻¹) than autumn (1950 ± 390 cells L⁻¹), winter (2180 ± 370 cells L⁻¹), and summer (2490 ± 480 cells L⁻¹) in red bloom fishponds. High nutrients might favor the growth of euglenophytes (*Euglena sanguinea*) causing red bloom fish ponds of Nepal.

This abstract was excerpted from the original paper, which was published in [Our Nature \(2016\); 14\(1\): 71-77](#).

Characterization of the nutritional quality of amaranth leaf protein concentrates and suitability of fish meal replacement in Nile tilapia feeds (17-370)

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A number of leafy vegetables, their protein concentrates and hydrolasates are under evaluation as alternative protein ingredients to fish meal (FM) in aquafeeds. This study evaluated the nutritional characteristics and suitability of replacing FM with the amaranth (*Amaranthus hybridus*) leaf protein concentrates (ALPC) as a protein ingredient in the diet of Nile tilapia (*Oreochromis niloticus*). Experimental diets were formulated, where 100%, 75%, 50%, 40%, 20% and 0% FM protein was substituted by protein from ALPC. The six dietary treatments were tested in triplicate in static flow-through tanks. The substitution effects were

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compared in terms of fish growth performance, nutrient utilization, whole body composition and apparent nutrient digestibility. After 160 days of feeding, the growth, nutrient utilization and Feed Conversion Ratio (FCR) in fish fed diets containing 100%, 75%, 50%, 40% and 20% FM were better ($P < 0.05$) than those fed diet with 0% FM. The apparent nutrient digestibility was high for protein, lipid and energy and differed significantly among the dietary treatments ($P < 0.05$). Protein digestibility in fish was highest in feed formulated with 100%, 75%, 50% and 40% FM, which were significantly ($P < 0.05$) higher than at 25% and 0% FM. Lipid digestibility was comparable for all the diets except fish fed 0% FM. Digestible carbohydrates and dry matter were similar for all dietary treatments ($P < 0.05$). We demonstrate that it is possible to replace up to 80% of fish meal with ALPC without compromising the performance of *O. niloticus*. These results demonstrate that although it is possible to replace large part of fish meal with ALPC, it is not possible to eliminate it in Nile tilapia diet as alternative protein ingredient.

This abstract was excerpted from the original paper, which was published in [Aquaculture Reports 5 \(2017\) 62-69](#).

UPCOMING MEETINGS AND EVENTS

Seafood Summit 2017
5-7 June 2017
Seattle, WA, US
www.seafoodsummit.org/

World Aquaculture 2017
27-30 June 2017
Cape Town, South Africa
www.was.org

Agriculture to Nutrition Scientific Symposium
9-13 July 2017
Kathmandu, Nepal
www.nutritioninnovationlab.org

Asia Pacific Aquaculture 2017
25-27 July 2017
Kuala Lumpur, Malaysia
www.was.org

Women's Worlds Congress/Doing Gender 11
30 July – 4 August 2017
Florianópolis, Brazil
<http://bit.do/wwc2017>

EADI NORDIC Conference 2017
21-23 August 2017
Bergen, Norway
www.eadi-nordic2017.org/

GOAL 2017
3-6 October 2017
Dublin, Ireland
www.gaalliance.org/goal/

Aquaculture Europe 2017
16-20 October 2017
Dubrovnik, Croatia
bit.ly/AquaEuro2017

For more meeting and employment opportunities visit our Education and Employment Opportunities network database online, EdOpNet, at aquafishcrsp.oregonstate.edu/edop.php

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PARTING SHOT



(Photo courtesy AquaFish Innovation Lab)

AquaFish partners and students visit research ponds at the National Fisheries Resources Research Institute during a site visit in Uganda.

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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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