



RESEARCHERS CHARACTERIZE TILAPIA GUT MICROBIAL COMMUNITIES WITH EYE TOWARD IMPROVING FEED EFFICIENCY

Findings suggest a pulsed feeding strategy can boost diversity of some microbes and produce greatest net return for fish farmers

**By Briana Goodwin
and Morgan Chow**
AquaFish Innovation Lab

Aquaculture growth for smallholder farms is often limited by a lack of access to affordable, high-quality feed.

Feed costs constitute 50 percent to 80 percent of production costs for tilapia, one of the most widely cultured species in the world.

AquaFish Innovation Lab researchers are investigating how to improve feed quality and reduce reliance on expensive feeds, aiming to increase productivity and sustainability of small-scale aquaculture operations in

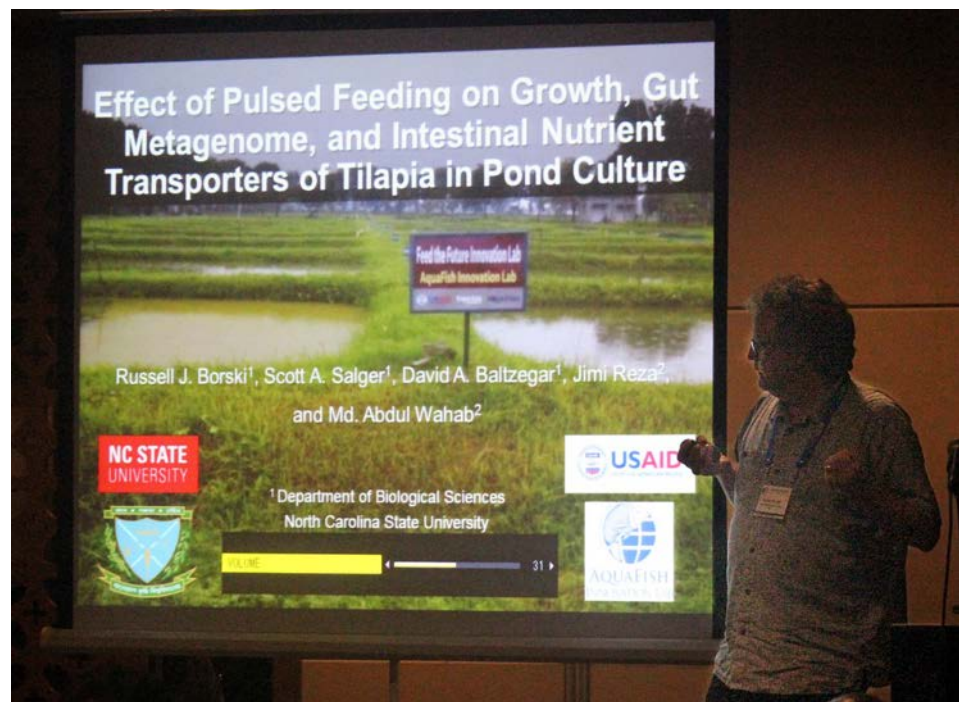


Photo courtesy of AquaFish Innovation Lab

US Project PI Dr. Russell Borski, of North Carolina State University, gives a presentation during AquaFish Innovation Lab's Technical Session on tilapia, during the 2016 Asian-Pacific Aquaculture Conference.

communities across the globe. community in tilapia.

One such investigation has looked at feed efficiency by characterizing the bacterial gut

AquaFish researchers from North Carolina State University

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Annual Meeting

AquaFish partners from 13 countries gathered and discussed ideas for sustaining the program's impact and legacy

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APA technical sessions

AquaFish-hosted sessions shine a light on partners' research and innovations in smallholder aquaculture technologies

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Photo courtesy of AquaFish Innovation Lab

Current and past AquaFish Innovation Lab research indicates that alternate-day (or pulsed) feeding and weekly pond fertilization in tilapia culture can aid fish farmers.

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(NCSU) and Bangladesh Agricultural University (BAU) performed experiments in order to examine how alternate-day feeding strategies affect nutrient absorption in Nile tilapia.

Gut microbiomes — or communities of bacteria and other microscopic organisms that live in digestive tracts — are essential for fish health as they contribute to efficient absorption of nutrients, maintaining energy balance, and immunity. The NCSU-BAU study characterized the bacterial gut community in tilapia to determine its impact on feed efficiency under different feeding regimes.

A genetic analysis of the fecal material of tilapia identified 145 families of prokaryotic bacteria (cellular organisms without membranes or nuclei) and 132 eukaryotic organisms (cellular or multicellular organisms whose cells contain membrane-bound nuclei and other structures). The highest diversity of eukaryotes was found in fish that were fed every other day (also known as pulsed feeding) with pond fertilization.

There were no significant differences in gene expression of nutrient transporters in any treatment that incorporated both feeding and

pond fertilization. Expression of the transporters was lower in fish that were fed daily without pond fertilization and higher in fish that were not fed and grown in fertilized ponds. Fish fed on alternate days had more moderate expression levels of certain transporters, which may allow for more balanced and efficient nutrient uptake.

These studies, along with previous AquaFish research, indicate feeding Nile tilapia on alternate days along with weekly pond fertilization can benefit fish farmers.

Specifically, this strategy of feeding has no negative effects on growth, survivability, or production and produces the greatest net return on investments. This work also suggests for the first time that combined feeding and fertilization produces the greatest biodiversity of microbes in the intestine, which could contribute to enhanced feed efficiency and overall health of tilapia, particularly those subjected to more moderate feeding strategies.

Researchers are continuing their work by studying how nutrients received in the early stages of growth impact the health of mature tilapia. This research aims to help fill a gap in knowledge about fish nutrition and to further develop efficient feed strategies for fish farmers.





Photo courtesy of AquaFish Innovation Lab

US Project PI Dr. Joe Molnar, of Auburn University, speaks during AquaFish Innovation Lab's Annual Meeting.

ANNUAL MEETING FOCUSES ON ACCOMPLISHMENTS AND LASTING IMPACTS

By Morgan Chow and Briana Goodwin

AquaFish Innovation Lab

AquaFish Innovation Lab partners from 13 countries gathered on 24–25 April 2016 for the AquaFish Annual Program Meeting in Indonesia's second largest city, Surabaya.

Partners gathered to reflect on the accomplishments of their work and discuss strategies for sustaining research and dissemination efforts after the grant ends.

Many discussions focused on sustaining the impact and legacy of AquaFish. The Cambodia project partners talked about the importance of personal and professional relationships that have developed over the years, while others mentioned the positive impact that AquaFish-trained students can have on the industry. Researchers are focusing on transferring skills and technologies to host country communities and thinking about how to leverage AquaFish-supported work to create new partnerships and collaborations.

Meanwhile, members of AquaFish advisory committees — the Regional Centers of Excellence (RCE) and External Program Advisory Council (EPAC) — suggested ways in which partners could take advantage of existing resources to continue their AquaFish-related work. RCE coordinator Dr. Wilfrido Contreras-Sanchez recommended that participants



Photo courtesy of AquaFish Innovation Lab

Among the AquaFish Innovation Lab partners at the Annual Meeting were (from left) Dr. Dilip Jha, Dr. Sunila Rai, Dr. Narayan Pandit, Dr. Madhav Shreshtha, Dr. Jay Dev Bista, and Dr. Liping Liu.

"take the next two years to prepare for the next 20 years," encouraging Host Country PIs to build strong networks and take advantage of the expertise currently within the AquaFish community. Both committees emphasized the PIs' sentiment that "students are very important for carrying technologies forward."

After the Annual Meeting, AquaFish partners attended the 2016 Asian-Pacific Aquaculture Conference (APA16), also in Surabaya, where five technical sessions were chaired by AquaFish (see page 4). As a sponsor of APA16, AquaFish had a booth at the conference's tradeshow, providing conference-goers a glimpse into the AquaFish program.



AQUAFISH PARTNERS' RESEARCH ON SMALLHOLDER TECHNOLOGIES HIGHLIGHTED IN APA SESSIONS

By **Susannah L. Bodman**
AquaFish Innovation Lab

AquaFish Innovation Lab partners gathered in Surabaya, Indonesia, this spring, not only for their annual meeting but also to participate in the Asian-Pacific Aquaculture Conference, held 27-28 April 2016.

Partners presented their research and results as part of five AquaFish-hosted technical sessions throughout the conference. AquaFish also had an exhibit booth and posters at APA.

These sessions created valuable opportunities for program partners and the research community to learn about AquaFish's research portfolio.

Topics for the five sessions (see list page 5) all pertained to innovations in smallholder aquaculture technologies, with focuses on tilapia, sustainable systems, snakehead, economics and marketing, and capacity building and gender. (The tilapia session was also part of the International Symposium on Tilapia in Aquaculture 11, held in Surabaya.)

Promoting smallholder aquaculture technologies is a focus of AquaFish because such technologies can promote the development of sustainable and innovative solutions local challenges in the aquaculture industry. Such challenges can include creating feed systems that reduce operating costs and increase fish farmer's income.

Atop the agenda of presentations was work by AquaFish US Project PI Dr. Russell Borski, of North Carolina State University. He and his co-authors explored the role of gut microbes in Nile tilapia nutrient utilization with an eye toward improving feed management strategies and ultimately reducing the cost of tilapia production. Borski's presentation, as part of the tilapia research session, was "Effect of pulsed feeding on growth, gut metagenome, and intestinal nutrient transporters of tilapia in pond culture."



Photo courtesy of AquaFish Innovation Lab

Audience members listen and ask questions of presenters during AquaFish Innovation Lab's Technical Session on tilapia.

Borski and co-authors found that feeding fish on alternate days (pulsed feeding) rather than every day had no impact on growth or production parameters but did reduce feed costs by 50 percent. They also found that Nile tilapia appear to use nutrients more efficiently when on a pulsed feeding schedule and that such feeding was associated with a greater diversity of intestinal organisms in the fish. (For more about this work, see cover story.)

On the topic of sustainable systems, Host Country Co-PI Dr. John Walakira of Uganda's National Fisheries Resources Research Institute and colleagues presented "Understanding sex change and hermaphroditism in African lungfish (*Protopterus aethiopicus*) and its implication to aquaculture: Preliminary findings."

Walakira's team researched the reproductive biology of feral African lungfish, with an eye toward developing technologies that aid in sustainable seed production in aquaculture and an end goal of improving livelihoods and

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AQUAFISH-HOSTED APA TECHNICAL SESSION PRESENTATIONS

SESSION I — INNOVATIONS IN SMALLHOLDER AQUACULTURE TECHNOLOGY: AQUAFISH RESEARCH ON TILAPIA

Effect of pulsed feeding on growth, gut metagenome, and intestinal nutrient transporters of tilapia in pond culture — Russell J. Borski, Scott Salger, David Baltzegar, Jimi Reza, and Md. Abdul Wahab

Evaluation of housefly *Musca domestica* maggot meal as protein source in Nile tilapia *Oreochromis niloticus* diets — Nazael A. Madalla, Tausi Ally, and Sebastian W. Chenyambuga

Efficacy of common carp *Cyprinus carpio* testis enducing sex reversal of Nile tilapia *Oreochromis niloticus* — Rahul Ranjan, Narayan Pandit, Nabin B. Khanal, Madhav Shrestha, and James Diana

Inclusion of Nile tilapia *Oreochromis niloticus* and sahar *Tor putitora* improves reproductivity in carp-polyculture system — Mahendra Bhandari, Rama N. Mishra, Madhav Shrestha, and James S. Diana

Assessment of value chain of farmed Nile tilapia (*Oreochromis niloticus*) in coastal and lake zones of Tanzania — Sebastian W. Chenyambuga, Elibariki E. Msuya and Nazael A. Madalla

Performance evaluation of blended virgin coconut oil on growth, feed utilization, body composition, body fatty acids, plasma metabolites of Nile tilapia (*Oreochromis niloticus*) and resistance to *Streptococcus iniae* challenge — Liping Liu, Andrews Apraku, Xiangjun Leng, Emmanuel J. Rupia, Christian Larbi Ayisi

SESSION II — INNOVATIONS IN SMALLHOLDER AQUACULTURE TECHNOLOGY: AQUAFISH RESEARCH ON SUSTAINABLE SYSTEMS

Aquaculture carrying capacity of Stung Chinit Reservoir, Cambodia: A pilot project — David Bengtson, Pheng Chheng, Puthearath Tith, Bunthang Touch, Nam So

Growth and production of carp and SIS in periphyton enhanced system — Sabita Jha, Sunila Rai, Madhav Shrestha, and James Diana

Effects of reduced feeding strategies for combined polyculture of two major carps (rohu and catla) with shing catfish (*Heteropneustes fossilis*) — Shahroz Mahean Haque, Imrul Kaiser, Moon Dutta, M.A. Wahab and Russell Borski

Spawning response of sahar *Tor putitora* in Terai region of Nepal — Subash Jha, Jay Bista, Narayan Pandit, Madhav Shrestha, and James Diana

Understanding sex change and hermaphroditism in African lungfish (*Protopterus aethiopicus*) and its implication to aquaculture: preliminary findings — John Walakira, John Kiburara, Arkanjelo Idrifua, Joseph Molnar, Eugrance Ganda, Godfrey Kityo, Cassias Aruho

SESSION III — INNOVATIONS IN SMALLHOLDER AQUACULTURE TECHNOLOGY: AQUAFISH RESEARCH ON SNAKEHEAD

Impacts of climate change on snakehead fish value chains in the lower Mekong Basin of Cambodia and Vietnam — Navy H., Minh T.H., and R.S. Pomeroy

Evaluating growth performance and immune responses of snakehead (*Channa striata*) by feeding plant protein diets supplemented with mannan oligosaccharide — Thi Thanh Hien Tran, Pham Minh Duc, Tran Minh Phu, Tran Le Cam Tu, Dang Thuy Mai Thy, and David Bengtson

Assessment on the current status of snakehead seed production in the Mekong Delta, Vietnam — Truong Hoang Minh, Tran Ngoc Hai and Robert Pomeroy

Sustainable snakehead aquaculture development in the lower Mekong Basin of Cambodia — Phanna Nen, Nam So, Seang Hay Pheng, Robert Pomeroy

SESSION IV — INNOVATIONS IN SMALLHOLDER AQUACULTURE TECHNOLOGY: AQUAFISH RESEARCH ON ECONOMICS AND MARKETING

Impact of stocking density and feeds on yield of *Pangasius catfish* (*Pangasius hypophthalmus*) in hyposaline waters — M. Lokman Ali, S. Mahean Haque, M. A. Wahab and Russell Borski

Price volatility in the African catfish reseller markets in Uganda — James O. Bukenya

Implementing mobile marketing and technical support for fish farmers: Uganda grower experiences and aspirations — Joseph Molnar, M. Matuha, G. Atukunda, J. Walakira, J. Terhune, J. Bukenya, S. Naigaga

An assessment of household food security in fish farming communities in Ghana — Kwamena Quagrainie and Akua Akuffo

Production and economic benefits of reduced feed inputs and addition of Indian carp (rohu) on Nile tilapia growout in ponds — Mst. Kaniz Fatema, Md. Abdul Wahab, S.A.S.A. Tahmid, Amit Pandit, S.M. Masud Rana, Shahroz Mahean Haque, and Russell J. Borski

Sustainable pearl farming in Africa using new spat collection techniques — Narriman S. Jiddawi and Maria C. Haws

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nutrition for communities in Uganda.

What they learned about lungfish reproduction included finding no evidence of hermaphroditism in two feral populations sampled, that lungfish will breed in tanks if induced with artificial hormones, and that determining sex of lungfish remains a challenge.

Under economics and marketing research, Host Country Co- PI Dr. M. Lokman Ali, of Patuakhali Science and Technology University in Bangladesh, and co-authors presented "Impact of stocking density and feeds on yield of *Pangasius catfish* (*Pangasius hypophthalmus*) in hyposaline waters."

The work assessed the potential for expanding *Pangasius* culture to southern regions of Bangladesh — areas characterized by sea-level rise, overfishing, and severe poverty. Much of Bangladesh's current *Pangasius* production occurs in the country's northern and central regions.

Implementing *Pangasius* culture in southern Bangladesh, such as in its Barisal District and other coastal areas, could double production of the catfish species and impact the diet and economies of coastal communities, the authors said in their presentation.

Research involved testing the impact of commercial and formulated feeds on stocking density and growth of *Pangasius*. Results indicated that a combination of high-stocking density and formulated feeds would yield the most profits for *Pangasius* culture in hyposaline waters, which are found in southern Bangladesh. The researchers also concluded that adoption of *Pangasius* culture in the nation's coastal regions can provide an alternative livelihood for communities impacted by increasing salinization of coastal waters due to climate change.

Meanwhile, in the area of capacity building and gender, Host Country Investigator Dilip Jha, of Agriculture and Forestry University (AFU) in Nepal, gave a talk on "Establishing school



Photo courtesy of AquaFish Innovation Lab

Snakehead fish are scooped up in 2014. Snakehead culture is one of many areas in which AquaFish Innovation Lab researchers are developing technologies.

ponds for educating students to improve health and nutrition of children and women in rural Nepal." Jha and colleagues focused on establishing school fish ponds and curriculum for school-aged children and women's groups in an effort to educate rural communities about aquaculture and the nutritional value of fish.

The work aimed to address global concerns about access to nutritious food among women and children, the role fish can play in providing high-quality proteins and other valuable nutrients, and the lack of awareness of the nutritional value of fish in rural communities.

Ponds were constructed at four public schools in Nepal and stocked with carps and Nile tilapia. Teachers and students also were given training and information on various aspects of fish farming, nutrition and fish preparation. In addition, local women's groups were formed and given workshop training on household aquaculture's role in family nutrition and income.

Jha and his co-authors concluded their work increased awareness about nutrition and fish consumption in rural households, generated income and educational opportunities for the schools, and led to teachers sharing information about fish and nutrition to parents.

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AQUAFISH SUPPORTS GENDER INTEGRATION AND EQUITY AT GAF CONFERENCE

By Kat Goetting, Stephanie Ichien
and Briana Goodwin

AquaFish Innovation Lab

AquaFish Innovation Lab has a long-standing commitment to create meaningful opportunities for men and women in the aquaculture and fisheries sector of the developing world. As a result, AquaFish works to align its program-wide gender integration efforts with current trends and initiatives in the development arena.

As part of this commitment, AquaFish Director Dr. Hillary Egna has been a key contributor to the Gender in Aquaculture and Fisheries (GAF) program supported by the Asian Fisheries Society. GAF aims to further gender research in aquaculture and fisheries development by facilitating the exchange of information. To this end, GAF



Photo courtesy of AquaFish Innovation Lab

AquaFish Innovation Lab Director Dr. Hillary Egna poses with (from left) Dr. Meryl Williams, Dr. Amonrat Sermwatanakul, and Nikita Gopal, who organized of the 6th Symposium on Gender in Aquaculture Forum, held 4–6 August 2016 in Bangkok, Thailand.

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SESSION V — INNOVATIONS IN SMALLHOLDER
AQUACULTURE TECHNOLOGY: AQUAFISH RESEARCH
ON CAPACITY BUILDING AND GENDER

Improving the well-being of Bangladeshi women mud crab culturist using a value chain analysis — Wilfred Jamandre, Upton Hatch, Sattyananda Biswas, Emilia Quinitio, Md. Abdul Wahab, Sadika Haque, Russell Borski

Establishing school ponds for educating students to improve health and nutrition of children and women

in rural Nepal — Dilip Jha, Narayan Pandit, Ishori S. Mahato, Madhav Shrestha, and James Diana

Fish and nutrient consumption among women and preschool children in rainy season in Cambodia — Touch Bunthang, So Nam, Chheng Phen, Pos Chhantana, En Net, and Robert Pomeroy

Role of the Aquafish Innovation Lab in university capacity building and aquaculture development in Nepal — Madhav K. Shrestha and James S. Diana

— SLB

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Also during the capacity building and gender session, Host Country Project PI Dr. Madhav Shrestha of AFU presented on the “Role of the Aquafish Innovation Lab in university capacity building and aquaculture development in Nepal.”

With collaboration and support from AquaFish over the years, AFU has strengthened its human and institutional capacity through curriculum and degree-program development, support of long-term degree-seeking students, and the facilitation of faculty and student participation at academic and professional conferences.

Shrestha and co-author and US Project PI Dr. James Diana, of the University of Michigan, said AquaFish had been “instrumental” in the establishment of AFU and that its funding and the opportunities it helped create for faculty, students and others “produced substantial gains for aquaculture development in Nepal and helped the university develop a better infrastructure and training program for the future.”

Full abstracts and presentation slides are available for viewing on the AquaFish website, <http://goo.gl/NGEYH3>.



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organizes gender-specific sessions at international aquaculture and fisheries conferences and hosts several digital opportunities for information exchange, providing open forums for regular discussions and innovation in the field.

Successful aquaculture development depends on building and sustaining a gender-balanced community of students, professionals, and community members. However, women's potential to contribute to broad goals such as agriculture sector growth and improved nutrition is limited by restricted market opportunities, lack of access to education, unequal economic participation, and unequal involvement in decision-making. Focusing on gender equality and taking a holistic approach to aquaculture development not only benefits the industry, but individuals, households, and communities flourish as well.

AquaFish has adopted a versatile approach to promote gender equity in the aquaculture sector and increase the retention of women in the aquaculture industry upon completion of training. To achieve this, AquaFish strives to ensure there are equal opportunities in all AquaFish training activities, provide project leadership roles to empower women scientists and administrators, conduct research that focuses on women's roles in aquaculture, and monitor and evaluate gender inclusiveness.

One way of ensuring these efforts remain relevant and effective is regular participation in international conferences and supporting opportunities for others to do so as well.

In a commitment to foster the exchange and dissemination of ideas on gender in aquaculture, AquaFish served as a Platinum sponsor for the 6th Global Symposium on Gender in Aquaculture and Fisheries (GAF6). Dr. Egna served as co-chair of the symposium's organizing committee as well.

GAF6 took place as part of the 11th Asian Fisheries and Aquaculture Forum in Bangkok, Thailand, and was packed with 68 oral and poster presentations addressing the importance of



Photo courtesy of AquaFish Innovation Lab

Host Country Investigator Dr. Sunila Rai of Agriculture and Forestry University in Nepal speaks during the 6th Symposium on Gender in Aquaculture Forum.

AQUAFISH GAF6 PRESENTATIONS

ORAL PRESENTATIONS

An overview of women in aquaculture and fisheries in Bangladesh — K. Fatema

Improving nutritional status and livelihoods for marginalized women households in southwest Bangladesh through aquaculture — S.H. Haque, M. Rahman, S. Biswas Satu, R. Borski, and H. Egna

POSTER PRESENTATIONS

Gender dimensions in disaster management: Implications for coastal aquaculture and fishing communities in the Philippines — M. Chow and H. Egna

A multifaceted approach to closing the gender gap in aquaculture for improving global nutrition — J. Borberg, M. Chow, S. Ichien, and H. Egna

BOTH

Participation of women farmers in an on farm training of sustainable periphyton enhanced system — S. Rai, M. Shrestha, and J. Diana

Examining gender authorship in aquaculture journals — M. Chow and H. Egna

Women-led river bank aquaculture for livelihoods of rural poor community in foot hills of Nepal — M.K. Shrestha, K.K. Amatya, and J.D. Bista

— SLB



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Photo courtesy of AquaFish Innovation Lab

AquaFish Innovation Lab partners and Management Team members gather at the AquaFish exhibit at the 11th Asian Fisheries and Aquaculture Forum, held 3–7 August 2016 in Bangkok, Thailand.

AQUAFISH PARTNERS JOIN AQUACULTURE PROFESSIONALS FROM AROUND THE WORLD AT 11AFAF

By Stephanie Ichien

AquaFish Innovation Lab

Hosted by the Asian Fisheries Society and the Network of Aquaculture Centers in Asia-Pacific, the 11th Asian Fisheries and Aquaculture Forum (11AFAF) took place at the Bangkok International Trade and Exhibit Center from 3–7 August 2016 in Bangkok, Thailand, in conjunction with the ASEAN Fisheries and Aquaculture Conference and Exposition.

As the Gold Sponsor, the AquaFish Innovation Lab had a booth in the exposition space

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gender integration and equity in aquaculture and fisheries research. Topics included engendering fish trade and value chains, climate change adaptation, disaster preparedness, and gender integration in fishing communities.

Among the many presentations at GAF6 by AquaFish researchers (see list 8), Dr. Egna presented research that she and former AquaFish-supported student Morgan Chow conducted about gender authorship in aquaculture journals. Stimulating discussion, this presentation

11AFAF POSTERS PRESENTED BY AQUAFISH RESEARCHERS

Carp brood stock management in private hatcheries of Nepal — Dilip K. Jha, Ram Bhujel, and Anil K. Anal

Dynamics of red bloom algae in fishponds in three different region of Nepal — Ram Bhajan Mandal, Sunila Rai, Madhav Kumar Shrestha, Dilip Kumar Jha, and Narayan Prasad Pandit

Status of tilapia culture in Nepal — Narayan Prasad Pandit and Madhav K. Shrestha

Status of Pangasius (*Pangasiondon hypophthalmus*) aquaculture in Nepal — Nabin Khanal and Madhav K. Shrestha

Developing feed formulation for snakehead (*Channa striata*) culture — Tran Thi Thanh Hien, Tran Le Cam Tu, Tran Minh Phu, Pham Minh Duc, Bui Minh Tam, and David Bengtson

Observation of the performance of wild jalkapur fry (*Pseuotropius murus batarensis*) in ponds in Trishuli, Nuwakot — Kamala Gharti, Gopal Prasad Lamasal, and Suresh Kumar Wagle

Studies in fungi and bacteria infection to snakehead (*Channa striata*) culture in Mekong Delta Vietnam — Pham Minh Duc and Tran Thi Thanh Hien

Diversity and marketing system of dried fish products in Nepal — Neeta Pradhan, Madhav Shrestha, Sunila Rai, and Dilip K. Jha

Integrating the culture of indigenous species with climate-smart aquaculture — Stephanie Ichien, Morgan Chow, and Hillary Egna

— SLB



was one of many research topics on innovative ways to explore gender equity in aquaculture and fisheries.

In an effort to progress gender integration research in fisheries and aquaculture, GAF6 also included its first GAF-101 training workshop titled "Theorizing Gender in Aquaculture and Fisheries Research."

For more information on GAF6 and to view the GAF-101 training workshop, go to <https://genderaquafish.org/>.



SCIENTISTS RECEIVE EARLY CAREER SUPPORT VIA AQUAFISH-SPONSORED AWARDS

By **Susannah L. Bodman**

AquaFish Innovation Lab

Increasing food security, nutrition, and gender inclusiveness worldwide through aquaculture begins with building capacity in research, education, and outreach. To that end, AquaFish Innovation Lab and its partners support early career scientists to help them to present their work and build professional networks at international scientific conferences.

Evidence of this support recently came in the form of awards given at the 11th Asian Fisheries and Aquaculture Forum and Exhibition (AFAF), held 3–7 August 2016 in Bangkok, Thailand, and the International Institute of Fisheries Economics and Trade (IIFET) Conference 2016, held 11–15 July 2016 in Aberdeen, Scotland, UK.

At 11AFAF, two young scholars were honored with Yang Yi Young Scientist Fellowships: Laila M. Gallego of National Taiwan Ocean University and Isagani P. Angeles Jr. of the Philippines' Isabela State University.

Administered by the Asian Fisheries Society, Yang Yi awards are currently given out every three years through a nomination and application process to help two young scientists make their way to AFAF conferences to present their research.

Gallego presented "Effects of antioxidant



Photo courtesy of AquaFish Innovation Lab
Isagani P. Angeles Jr. (left) and Laila M. Gallego (right), recipients of the 2016 Yang Yi Young Scientist Fellowships, show off their certificates with AquaFish Innovation Lab Director Dr. Hillary Egna (center) at the 11th Asian Fisheries and Aquaculture Forum and Exhibition.

supplements in growth, survival, antioxidant capacity, immune response, metabolic response and oxidative stress status of Pacific white shrimp (*Litopenaeus vannamei*)," while Angeles gave his talk on "Fermented banana (*Musa* spp.) peel improves growth and red blood cells of Nile tilapia (*Oreochromis niloticus*)."

AquaFish Director Dr. Hillary Egna created the awards in 2010 to honor the memory of Dr. Yang Yi — a longtime partner of AquaFish, the Aquaculture Collaborative Research Support

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along with myriad other groups involved in fisheries and aquaculture. The many attending AquaFish partners were able to display their materials, gather, and meet in this shared space.

Building on these contributions at the conference, AquaFish participants also presented several papers in various sessions and displayed nine posters featuring AquaFish research and accomplishments (see list page 9). Furthermore, two young scientists were able

to present at the conference thanks to Yang Yi Young Scientist Fellowships (see story above).

The triennial 11AFAF conference successfully brought together fisheries and aquaculture researchers and professionals from around the world.

For more information about the conference, go to the 11AFAF handbook, bit.ly/11AFAFhandbookAF, and bit.ly/11AFAFprogramAF on the AquaFish website.





Photos courtesy of AquaFish Innovation Lab

Suthamathy Nadarajah (left in left photo) of the University of Tromsø received the Best Student Paper award, sponsored by AquaFish Innovation Lab, during the International Institute of Fisheries Economics and Trade (IIFET) Conference 2016. Pictured with her is her major professor, Dr. Ola Flaaten. Also at IIFET, Md. Akhtaruzzaman Khan (left in right photo) of Bangladesh Agricultural University receives his Best Paper for the Economics of Sustainable Aquaculture Development award, also sponsored by AquaFish. Shaking hands with Khan is IIFET President Dan Holland.

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Program and Pond Dynamics/Aquaculture CRSP — who died in 2009.

Since the award's creation, several young scientists have been able to present at conferences thanks to the award. Recipients currently must be younger than age 35, have a PhD or be pursuing one, and must give an oral presentation about their work at AFAF.

Past recipients of the award are: Zexia Gao, Narayan Prasad Pandit, Youji Wang, Dongmei Zhu, and Kang Li.

For more information on the Yang Yi award, go to a February 2016 post on the Asian Fisheries Society website, <http://goo.gl/xZVO77>. To read more about Dr. Yi, go to AquaFish's memorial page at <http://aquafishcrsp.oregonstate.edu/YangYi/>.

Earlier in the year at IIFET 2016, several presenters won best paper awards, which were sponsored by AquaFish.

The AquaFish awards, the recipients, their affiliations, and papers were:

- **AquaFish Best Student Paper for Aquaculture Economics in Developing Countries** — Suthamathy Nadarajah, University of Tromsø–The Arctic University of Norway, for “Global aquaculture growth and institutional quality.” (Co-author: Ola Flaaten)
- **AquaFish Best Paper for the Economics of Sustainable Aquaculture Development** — Md. Akhtaruzzaman Khan, Bangladesh Agricultural University, for “Production risk, inefficiency, and sustainability of Pangas fish farming: Lessons from the Bangladesh aquaculture sector.”
- **Best Aquaculture Economics Paper (The AquaFish Prize)** — Martin Smith, Duke University, US, for “Disease risk and market structure in salmon aquaculture. (Co-authors: Carolyn Fischer and Atle G. Guttormsen)

For more information on IIFET 2016, go to www.iifet-2016.org/.





Photos courtesy of AquaFish Innovation Lab

AquaFish Innovation Lab Director Dr. Hillary Egna (right) accepts honors from the Asian Fisheries Society in August 2016, accompanied by AquaFish Host Country PI Dr. Madhav Shrestha of Agriculture and Forestry University in Nepal. Dr. Egna received a Gold Medal Award for herself, while AquaFish was honored with an all-team Gold Award (left).

AFS HONORS AQUAFISH AND ITS DIRECTOR FOR LONGTIME SUPPORT

By **Susannah L. Bodman**

AquaFish Innovation Lab

AquaFish Innovation Lab and its director, Dr. Hillary Egna, were recently honored by the Asian Fisheries Society (AFS) with Gold Medal awards.

Dr. Egna was recognized for her support of AFS activities as well as her decades-long efforts to mentor and support the work of many young scientists from the Asia-Pacific region.

Meanwhile, AquaFish received a separate, all-team award in recognition of its support of AFS.

The awards were given during the 11th Asian Fisheries and Aquaculture Forum (11AFAF), held 3–7 August 2016 in Bangkok, Thailand.

AquaFish was a Gold Sponsor of 11AFAF, a triennial conference presented by the AFS.

Dr. Egna and AquaFish have focused attention on supporting research and scientists in the Asia-Pacific region as part of its wider mission to build capacity and to increase food security, nutrition, and gender inclusiveness worldwide through aquaculture research and outreach.



SPRUCED BOOTH

AquaFish Innovation Lab Associate Director Dr. Ford Evans hangs photos at the AquaFish exhibit at the 11th Asian Fisheries and Aquaculture Forum, held 3–7 August 2016 in Bangkok, Thailand.

Photo courtesy of AquaFish Innovation Lab

AQUAFISH ALUMNI CORNER

RECENT GRADUATE PROFILE: KHOP NARAYAN SHRESTHA

By **Susannah L. Bodman**
AquaFish Innovation Lab

I'd been more than 30 years since Khop Narayan Shrestha earned his undergraduate degree in agriculture, but something about aquaculture drew him back to school.

For Shrestha, that something was a lack of development of aquaculture in the hilly and mountainous regions of Nepal despite abundant water resources. While 94% of fishponds are found in the plains of Nepal, there is a need to promote fish farming into the country's hills and mountains, he said. Overall, aquaculture in Nepal has been gradually growing since its origins with small-scale carp production in the 1940s.

Shrestha, whose graduate studies at Nepal's Agriculture and Forestry University (AFU) were supported by AquaFish Innovation Lab for two years, is executive director of the nongovernmental organization Manahari Development Institute (MDI)-Nepal, which has been involved in promoting small-scale carp and small-indigenous-species fisheries in rural areas of Central Nepal's Makawanpur District (400 m altitude) and aquaculture using common carp in Jumla District (2,500 m altitude). As director, Shrestha focuses on the MDI's proposals, coordination with donor agencies and supervising day-to-day operations.

Through his work with MDI-Nepal, Shrestha helps to promote development of rural and high-elevation fisheries, local fish conservation, and the use of various fish species for income. This work gave him insights into the wide-reaching benefits of aquaculture.

"I came to realize then that aquaculture and fisheries could be one of the reliable interventions to support livelihoods and nutrition in the rural areas," Shrestha said.



*Photo courtesy of
Khop Narayan Shrestha*

Khop Narayan Shrestha, who recently earned a Master's degree from Nepal's Agriculture and Forestry University thanks to AquaFish Innovation Lab support, is director of Manahari Development Institute, which promotes small-scale fisheries in rural central Nepal.

A native of Khoplang-9, Gorkha District, Shrestha recently defended his Master's thesis for a Master of Science degree in aquaculture at AFU and earned a Bachelor of Science degree in agriculture from Nepal's Tribhuvan University in 1982.

His graduate thesis was titled "Growth and production of carp and tilapia in polyculture at different altitudes of Nepal." Major professors were Drs. Madhav Kumar Shrestha, Dilip Kumar Jha, and Sunila Rai — all AquaFish partners at AFU.

While tilapia cultivation is expanding worldwide, Shrestha said it is not commercially cultivated in Nepal. "Farmers are less aware of its importance. They grow only carps," he said.

Most of the fishponds that do exist in the country are located in Nepal's warmer Terai plains, he said. However, most of the country's land area is covered by hills and mountains with large, untapped water resources.

So Shrestha designed his research to test the growth patterns of carp and tilapia reared in polyculture systems at higher altitudes — 300 m, 700 m, and 1,870 m. The research was conducted from June to November 2014 and involved silver, bighead, grass, and common carps as well as Nile tilapia.

What he found was that growth and production of all species decreased with increasing altitude and that common carp performed better

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than other carps in all treatments. Also, Nile tilapia came in second after common carp for growth performance at all altitudes, and tilapia and common and grass carps outperformed silver and bighead carps at higher altitudes.

"(I)t can be concluded that these three species combinations, i.e., common carp, grass carp, and Nile tilapia, are suitable for culture at higher altitudes of Nepal," Shrestha said.

Another finding that emerged was that despite declining growth and production with increasing altitude, the gross margin for carp-tilapia remained positive, indicating polyculture is feasible at higher altitudes, he said.

Since then, Shrestha and other Master's degree students at AFU conducted work with carp at 2,566 m altitude in Jumla, along with other MDI projects.

"This year, we have been able to make a successful spawning of common carp, thereby a successful hatching, probably for the first time," he said.

Next steps in Shrestha's research could involve testing growth patterns through the year to compare growth performance in colder versus warmer months of the year. Shrestha said he hopes to secure funding by next year to make the research possible.

As for the future of Nepalese aquaculture: "Fisheries and aquaculture have emerged as potentially an important sector of Nepalese agriculture. It is among the fastest growing sectors in agriculture," he said, adding that aquaculture's annual growth rate in Nepal is 8.4%.

However, challenges remain in the form of competition from a large volume of imported fish, which creates pressure that keeps domestic per-capita production low (2.3 kg).

"Thus, increasing fish productivity as well as total production in the country is a challenging task and is necessary in order to meet increasing demand for fish without increasing import from neighboring countries," Shrestha said.

Other hurdles to developing Nepal's aquaculture sector include weak transportation networks in hilly areas, making the movement of seed fish and fingerlings difficult.

"We need to develop breeding centers at least for possible species in accessible areas so that people can get the seeds/fingerlings easily. I think this cost is low compared to building larger road networks only," Shrestha said.

As for feed production, Shrestha said Nepal has enough land to cultivate feed crops and therefore feeds likely won't be a limiting factor for the aquaculture sector.

Meanwhile, Shrestha plans to continue promoting aquaculture in Nepal's hilly and mountainous regions and keep researching various species (e.g., tilapia and common carp) and sustainable technologies that could be recommended to small-scale farmers. He said, in the next five years, he'd like to be involved in the promotion and development of fish-farming technology for smallholder farmers through MDI and the nongovernmental organization sector.

He also will likely be reading AquaNews, of which he said he was a regular reader. The benefit of the publication, he said, was that he "could learn some new innovative ideas in aquaculture science that has been practiced around the globe."



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Effects of replacing fish meal with soya protein concentrate on growth, feed efficiency and digestibility in diets for snakehead, *Channa striata* (16-360)

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Soya bean meal-based formulated feeds have recently become available for snakehead culture in Vietnam. This study was conducted to determine the appropriate replacement of fish meal (FM) protein by another soya product, soya protein concentrate (SPC), in snakehead (*Channa striata*) diets. Five iso-nitrogenous (45% crude protein) and isocaloric (19 KJ g⁻¹) practical diets were formulated to replace 0% (control), 40%, 60%, 80% and 100% of protein FM by protein SPC (100% FM, 40% SPC, 60% SPC, 80% SPC and 100% SPC respectively). A digestibility experiment was also conducted with the same formulated diets with addition of 1% chromic oxide. Fish fed 100% FM and 40% SPC diets had significantly better growth and survival compared with other treatments. Feed intake, feed conversion ratio, protein efficiency ratio and net protein utilization, trypsin and chymotrypsin activities of experimental fish fed 100% FM and 40% SPC diets were significantly higher than those fed other diets. The apparent digestibility coefficient (ADC) of the diet and diet components, ADC_{diet}, ADC_{protein} and ADC_{lipid} of fish fed diet 40% SPC and 100% FM treatment were significantly higher than those of other treatments. The cost/kg fish produced in diets 100% FM and 40% SPC was much lower compared with other treatments. Dietary inclusion levels of SPC in diet above 40% significantly affected fish survival, growth, digestibility and trypsin and chymotrypsin activities, although fish chemical composition was not greatly affected.

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Control of leptin by metabolic state and its regulatory interactions with pituitary growth hormone and hepatic growth hormone receptors and insulin like growth factors in the tilapia (*Oreochromis mossambicus*) (16-361)

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Leptin is an important cytokine for regulating energy homeostasis, however, relatively little is known about its function and control in teleost fishes or other ectotherms, particularly with regard to interactions with the growth hormone (GH)/insulin-like growth factors (IGFs) growth regulatory axis. Here we assessed the regulation of LepA, the dominant paralog in tilapia (*Oreochromis mossambicus*) and other teleosts under altered nutritional state, and evaluated how LepA might alter pituitary growth hormone (GH) and hepatic insulin-like growth factors (IGFs) that are known to be disparately regulated by metabolic state. Circulating LepA, and *lepa* and *lepr* gene expression increased after 3-weeks fasting and declined to control levels 10 days following refeeding. This pattern of leptin regulation by metabolic state is similar to that previously observed for pituitary GH and opposite that of hepatic GHR and/or IGF dynamics in tilapia and other fishes. We therefore evaluated if LepA might differentially regulate pituitary GH, and hepatic GH receptors (GHRs) and IGFs. Recombinant tilapia LepA (rtLepA) increased hepatic gene expression of *igf-1*, *igf-2*, *ghr-1*, and *ghr-2* from isolated hepatocytes following 24 h incubation. Intraperitoneal rtLepA injection, on the other hand, stimulated hepatic *igf-1*, but had little effect on hepatic *igf-2*, *ghr1*, or *ghr2* mRNA abundance. LepA suppressed GH accumulation and *gh* mRNA in pituitaries in vitro, but had no effect on GH release. We next sought to test if abolition of pituitary GH

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via hypophysectomy (Hx) affects the expression of hepatic *lepa* and *lepr*. Hypophysectomy significantly increases hepatic *lepa* mRNA abundance, while GH replacement in Hx fish restores *lepa* mRNA levels to that of sham controls. Leptin receptor (*lepr*) mRNA was unchanged by Hx. In in vitro hepatocyte incubations, GH inhibits *lepa* and *lepr* mRNA expression at low concentrations, while higher concentration stimulates *lepa* expression. Taken together, these findings indicate *LepA* gene expression and secretion increases with fasting, consistent with the hormones function in promoting energy expenditure during catabolic stress. It would also appear that *LepA* might play an important role in stimulating GHR and IGFs to potentially spare declines in these factors during catabolism. Evidence also suggests for the first time in teleosts that GH may exert important regulatory effects on hepatic *LepA* production, insofar as physiological levels (0.05–1 nM) suppress *lepa* mRNA accumulation. Leptin A, may in turn exert negative feedback effects on basal GH mRNA abundance, but not secretion.

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Demand for improved fish feed in the presence of a subsidy: A double hurdle application in Kenya (16-362)

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Fish farming households' demand for improved fish feed from the private market in Kenya is potentially influenced by the government's feed subsidy program. This article applies the double-hurdle model to a cross-section of fish farms to analyze demand for improved fish feed from private markets, and whether the government feed subsidy program has an effect on private demand for improved feed. The results indicate that households' decisions to participate in the improved feed market are affected by the quantity of improved feed received from the government. Once the participation decision has been made, we find evidence of crowding-in of the private improved feed sector; that is, the government's allocations of subsidized feed appear to increase private sector demand. In addition, the price

of improved feed negatively affects the quantity purchased as expected. Education, extension contacts, and ease of marketing matured fish increase household propensity to purchase improved feed commercially. Policies that help reduce the price of improved feed such as reduction in tariffs on imported feeds and feed ingredients will foster demand for the feed, as will policies that facilitate marketing of fish at reasonable prices by households.

This abstract was excerpted from the original paper, which was published in *Agricultural Economics* (2016). DOI: 10.1111/agec.12261.

UPCOMING MEETINGS AND EVENTS

Aquaculture Europe 2016

20–23 September 2016

Edinburgh, Scotland

bit.ly/AquacultureEurope2016

Latin American and Caribbean

Aquaculture 2016

28 November–1 December 2016

Lima, Peru

<http://www.marevent.com/LACQUAA2016PERU.html>

Aquaculture America

19–22 February 2017

San Antonio, Texas, US

<http://www.was.org/>

World Aquaculture 2017

27–30 June 2017

Cape Town, South Africa

<http://www.was.org/>

Asia Pacific Aquaculture 2017

25–27 July 2017

Kuala Lumpur, Malaysia

<http://www.was.org/>

Aquaculture Europe 2017

16–20 October 2017

Dubrovnik, Croatia

bit.ly/AquaEuro2017

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