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AQUANEWS

Sustainable Aquaculture and Fisheries for a Secure Future

Feed the Future Innovation Lab for Collaborative Research on Aquaculture & Fisheries

Volume 32, Number 3/Fall 2017 Contact us at aquafish@oregonstate.edu ISSN 1062-4998

View AquaNews at aquafishcrsp.oregonstate.edu/page/aquanews

Major Milestone Achieved in Launching Africa Chapter at World Aquaculture 2017

By Lindsay Carroll and Kat Goetting
AquaFish Innovation Lab

History was made in Cape Town, South Africa, in June 2017, when the World Aquaculture Society (WAS) launched its Africa Chapter at the World Aquaculture 2017 conference. This was the first year Africa hosted the WAS conference, making World Aquaculture 2017 the perfect platform to bring together members from across the continent to support the formation of an Africa chapter.

Africa now joins the USA, Korea, Asia-Pacific, and Latin America and Caribbean as a fully-affiliated chapter of WAS. Forming the Africa chapter provides the forum needed to address Africa's diverse and growing aquaculture sector and further develop a community of aquaculture professionals.

(Photo Courtesy of Charles Ngugi)

Many gather in support of the launch of the World Aquaculture Society's Africa Chapter at World Aquaculture 2017 in Cape Town, South Africa.

The road to chapter formation was years in the making. Dr. Hillary Egna, Director of AquaFish, recently found an old letter from 1992 from Thomas Omara-Alwala at Virginia

CHAPTER LAUNCH continued on page 2 ...

Optimizing Snakehead Feed in Mekong Delta

Researchers are supplementing snakehead feed with vitamin C to enhance fish growth.

Page 4

Aquacultural Benefits in Nepal and Bangladesh

Women share the nutritional and economic benefits of aquaculture to thier households.

Page 5

Also Inside

Gender Sector of GAF.....7
World Aquaculture 2017.....8
Student Corner.....10
Alumni Corner.....11
Publications.....13
Meetings and Events.....16

... CHAPTER LAUNCH continued from page 1

State University rallying to attract members and launch an African Aquaculture Society. Chapter formation discussions were raised again at several subsequent WAS meetings, including Aquaculture America (AA) 2007 in San Antonio, Texas, USA, World Aquaculture 2008 in Busan, South Korea, and again at AA 2012 in Las Vegas, Nevada, USA.

The most recent momentum toward chapter formation was driven by current acting Chair of the Steering Committee, Dr. Khalid Salie, a long-time AquaFish partner and senior lecturer at Stellenbosch University in South Africa. AquaFish played a key role advertising chapter formation across AquaFish networks to encourage collaboration and membership. Dr. Egna, Drs. Charles Ngugi and Steve Amisah (AquaFish Africa Regional Coordinators), and other AquaFish partners were strong supporters of forming a WAS Africa Chapter.

Prior to the launch meeting, WAS only had 89 members from Africa, many of whom were also AquaFish partners. On the day of the launch in June, however, the WAS Board of Directors recognized and approved 1,297 members from 33 African countries to join WAS and the Africa chapter.

Collaborators recognized sustainability challenges early in the chapter formation process, including payment of annual WAS membership and conference registration fees,

(Photo Courtesy of Charles Ngugi)

Kevan Main, previous WAS President, summarizes the requirements to form a WAS Africa Chapter at World Aquaculture 2017.

CHAPTER LAUNCH continued on page 3 ...

Goings-on in the Pond

AquaFish Trainings Reach Over 10,000 Participants

AquaFish reached an exciting milestone in Fall 2017. In just over 10 years, AquaFish collaborators trained MORE than 10,000 participants in aquaculture-related activities! AquaFish values developing and strengthening human capacity in partner countries by supporting post-secondary degree students and training aquaculture farmers, researchers, and professionals who can share and apply their knowledge on local levels. Learn more about this exciting achievement efforts on AquaFish's News and Events page and stay tuned for the full story in a future issue of AquaNews!

Dr. Steve Amisah Appointed Provost of College at KNUST

In October 2017, long-time AquaFish partner, Dr. Steve Amisah, was appointed Provost of the College of Agriculture and Natural Resources at Kwame Nkrumah University of Science and Technology (KNUST) in Ghana. Dr. Amisah has dedicated over 20 years of his career to KNUST and served a valuable role in AquaFish research projects in Ghana. Read more about his remarkable achievements in his profile on KNUST's website. AquaFish is honored to work with such a strong leader, who is committed to the advancement of aquaculture. Congratulations Dr. Amisah on your remarkable achievement!

BAU Ranked as #1 University in Bangladesh

AquaFish partner university, Bangladesh Agriculture University (BAU), was recently ranked first among all Bangladesh universities. The Cybermetrics Lab recognized BAU as the leader in overall visibility and impact of web publications. Congratulations to AquaFish partners from BAU! Read more about the ranking in the article published by the Daily Observer. Collaboration with AquaFish over the years has contributed to visibility of research and enabled BAU to build necessary capacity to develop multi-institutional collaborations within Bangladesh. The administrative infrastructure is essential to be competitive for future international awards and will provide a necessary foundation for the continued collaborations among institutions in Bangladesh and beyond.

... CHAPTER LAUNCH continued from page 2

(Photo Courtesy of Charles Ngugi)

Dr. William Daniels, current WAS president, proclaims Africa Chapter at World Aquaculture 2017 in Cape Town, South Africa.

as well as the lack of funds to support member travel to future WAS conferences. "Therefore, registered members need to experience the relevance and value of [the] Africa Chapter. This is the only way to consolidate the motivation of members to renew their subscription and enrich their experience," wrote Dr. Salie in Africa Chapter Initiative documentation.

The AquaFish network can provide insight to overcome these challenges. AquaFish and previous Aquaculture Collaborative Research Support Program (ACRSP) partners have contributed to WAS Chapter efforts in the past. In the early 2000s, ACRSP partners, Dr. Wilfrido Contreras-Sanchez and Dr. Maria Portella, played instrumental roles in further developing the Latin America and Caribbean (LAC) Chapter, originally established in 1994. Lessons learned and experiences gained from growing the LAC Chapter are critical and will serve as valuable resources. "We need help, especially from Asia and Latin America, on how to make it a success," said Dr. Ngugi.

Over 300 delegates attended the launch meeting in Cape Town, witnessing the coming of age of African aquaculture and the marking of a significant milestone for the global aquaculture community. AquaFish would like to extend congratulations to all AquaFish partners who helped in the process. Dr. Egna said, "I have worked with African colleagues towards chapter creation for nearly 15 years and I am delighted to see it finally lift off."

What's Next for the Chapter?

As a newly established WAS Chapter, the next steps include forming a Steering Committee with representation from various regions throughout Africa and developing bylaws, a financial plan, and strategies for expansion and retention of membership. With the support of WAS, the Africa Chapter plans to host a workshop in 2018. Be sure to visit wasafrica.com for more developments and updates!

AquaFish Research Optimizes Feed Used in Snakehead Culture in the Mekong Delta

By Lindsay Carroll, *AquaFish Innovation Lab*

(Photo courtesy of Pham Minh Duc)

Experimental ponds containing hapa cages used during snakehead feeding trials.

For over a decade, AquaFish partners in Cambodia and Vietnam have researched alternative methods to sustainably produce snakehead (*Channa striata*), one of the most valuable cultured fish in the Mekong River Delta. Total production of snakehead in the Mekong Delta increased rapidly from 14,478 metric tons in 2006 to 77,682 metric tons in 2016, justifying the need for pelleted diets with alternative protein sources to decrease the use of small, wild-caught fish as feed.

These small-sized fish are high in nutrients and serve as a valuable food source for lower income families in the Mekong Delta. Their use in snakehead culture increased fishing pressure on these native stocks and impacted the diets and overall security of families who depended on them. As a result of these pressures, Cambodia placed a ban on all snakehead farming in 2004, while snakehead farming continued in neighboring Vietnam.

To help address the reliance on small-sized fish in Cambodia, Vietnam, and in the Mekong Delta more broadly, research collaborations between Can Tho University in Vietnam, the Inland Fisheries Research and Development Institute in Cambodia, and University of Rhode Island, University of Connecticut, and Oregon State University in the US, worked to develop feed technologies and a more sustainable aquaculture program. An early breakthrough came when researchers formulated a pelleted feed with soy protein to be used as an alternative to small-sized fish. AquaFish researchers shared their results directly to feed manufacturers in the Mekong Delta leading to over 10 manufacturers committing to making the pelleted feed. In 2011, only 33% of Vietnamese snakehead farmers in 13 southern provinces used pelleted diets, but by 2015 more than 90% of those farmers used the pelleted feeds developed by AquaFish. These alternative feed technologies also contributed to the Cambodian government lifting the ban on snakehead farming in April 2016.

Soon after the pelleted feed was in use, farmers in Vietnam began to report that the fish fed pelleted feed often had a 'hunchback-like' appearance. On-farm, commercial-scale trials confirmed these reports and indicated that 20% of fish fed pelleted feed developed spinal column abnormalities, such as lordosis and scoliosis. These abnormalities are commonly associated with vitamin C deficiency, despite the fact that the feed originally contained levels previously thought to be adequate (80-150 mg vitamin C per kg of feed).

(Photo courtesy of Pham Minh Duc)

Formulated pellet feed used during snakehead feeding trials.

SNAKEHEAD FEED continued on page 5 ...

... SNAKEHEAD FEED continued from page 4

(Photo Courtesy of Pham Minh Duc)

Harvesting marketable-sized snakehead from hapa cages in ponds.

Vitamin C supplementation has several benefits, such as decreased likelihood of skeletal deformities and increased fish growth, survival, and disease resistance. Therefore, AquaFish collaborators incorporated laboratory and on-farm feeding trials into their next phase of research to determine the optimal dietary levels of vitamin C.

Results revealed that feed supplemented with 500 mg vitamin C per kg of feed, a larger amount than previously thought necessary, yielded optimal production costs and fish growth in commercial-scale farms. Improved fish health and fish growth from vitamin C supplemented feed has great potential for increasing farmers' incomes and decreasing negative environmental impacts by reducing reliance on previously declining stocks of wild fish. "Due to the initial success of vitamin C supplementation, feed manufacturers have already started incorporating vitamin C into feeds," said Dave Bengtson, AquaFish researcher from URI.

Collaborators will continue to build a more sustainable, and cost-effective strategy of snakehead culture that maximizes fish health and productivity in the Mekong Delta. Researchers hope their work further demonstrates that snakehead can be successfully and sustainably cultured using pelleted feeds in Cambodia, Vietnam, and beyond.

Household Women Share Nutritional and Economic Benefits of Aquaculture in Bangladesh and Nepal

By Samantha Farquhar, *Invited Contributor*

Samantha Farquhar recently graduated from the University of North Carolina Wilmington with Bachelor's degrees in Marine Biology and International Studies. After graduation, Samantha accepted a three-month research internship titled, "the socioeconomic impacts of aquaculture on women in Nepal" supported by Thailand's Asian Institute of Technology. The position placed her at the Agriculture and Forestry University in Rampur, Nepal, where she learned about AquaFish research efforts and more. She tells her story in the article below.

After graduating with a bachelor's degree in marine biology, I was surprised to find myself embarking on my next chapter in the landlocked country of Nepal. In January 2017, I accepted a research position through Thailand's Asian Institute of Technology that aimed to quantify the socioeconomic impacts of aquaculture on women. For three months, I was located in Rampur, Nepal, at the Agriculture and Forestry University (AFU), working with AquaFish Innovation Lab partners, Dr. Madhav Shrestha, Dr. Sunila Rai, and Dr. Dilip Jha.

Through support from AFU's Aquaculture and Fisheries Department, I travelled to the village

HOUSEHOLD WOMEN continued on page 6 ...

... HOUSEHOLD WOMEN continued from page 5

of Kathar, located southeast of Rampur, where I surveyed women about the nutritional and economic impacts of their household fish ponds. Survey questions asked women about fish consumption, income gained from fish farming, and their feelings of empowerment.

During my time at AFU, I was fortunate to meet additional AquaFish research partners from Nepal, Bangldesh, Cambodia, Vietnam, Thailand, China, and the United States at an AquaFish Regional Meeting in March 2017. Upon learning about my work, AquaFish researacher, Dr. Sadika Haque, extended an invitation to join her at Bangladesh Agriculture University (BAU) in Mymensingh to observe aquaculture practices and conduct additional surveys. I graciously accepted the offer and was excited for the opportunity to broaden my experiences and expand my research.

Upon arrival in Bangladesh and once beyond city limits, I was surrounded by lush, green rice paddies and vast sections of fish ponds. I traveled to a few different villages adjacent to Mymensingh, conducting surveys with Bangladeshi women that were similar to those I conducted in Nepal. To help translate the conversation, I enlisted the help of several BAU undergraduate and graduate students, one of which is a current AquaFish master's student. With their help, I was able to talk with the women about the role fish farming plays in their lives.

(Photo Courtesy of Samantha Farquhar)

Samantha Farquhar helping students from Agriculture and Forestry University clean a fish pond.

(Photo Courtesy of Samantha Farquhar)

Samantha Farquhar tries out traditional gear for the first time while in the village of Kathar in Nepal.

Throughout my surveys, the Nepali and Bangladeshi women expressed the positive economic and nutrional implications of aquaculture on their households and beyond. All Bangladeshi women surveyed reported fish farming was beneficial to their families. While Bangladeshi fish ponds produce and earn much more than Nepali fish farms, women involved in farming reported having little agency when it came to making business decisions or becoming economically independent.

Although, there are examples of women serving as sole owners of commercial fish farms in Bangladesh. One woman proudly told me, "I struggled to get here. I started off small, working the pond by myself. Then as I saved and grew, I began to hire local women to work on it. Now, I am proud to be in charge of the operation [English translation]."

HOUSEHOLD WOMEN continued on page 7 ...

... HOUSEHOLD WOMEN continued from page 6

Nepali women reported that the smaller-scale fish farms enabled them to earn money more directly by selling fish to neighbors and local markets. More women also said they are able to serve as managers of their ponds. My results also indicated that fish farming households consumed on average 50 kg more protein than non-fish farmers and women involved in fish farming reported stronger feelings of economic and food security. Aquaculture capacity continues to grow in Nepal, with the average Nepali fish farming household bringing in an additional $265 in net profit—almost 40% of the per capita GDP.

While Nepal and Bangladesh are on different aquaculture development scales, lessons can be learned from both localities. My term spent researching the socioeconomic impacts of aquaculture on women in Nepal and Bangladesh was an enlightening and rewarding experience. I was humbled by the kindness and hospitality shown by the Nepali and Bangladeshi women as they welcomed me into their homes and communities. I learned a lot from talking with them and I look forward to applying the knowledge and lessons learned as I begin my Master's degree in Marine and Environmental Affairs at the University of Washington.

AquaFish Role in Establishing the Gender in Aquaculture and Fisheries Section of the Asian Fisheries Society

By Lindsay Carroll, *AquaFish Innovation Lab*

AquaFish is working to secure a more stable future for gender equity and gender research in the Asian Fisheries Society (AFS) by helping support the establishment of the AFS Gender in Aquaculture and Fisheries Section (GAFS). AFS formally launched the GAFS in November 2017 at the 11th Indian Aquaculture and Fisheries Conference in Kochi, India, marking the first formal gender-affiliated section within a professional aquaculture or fisheries society. This milestone is a result of AFS's 20 plus year commitment to gender integration among the fisheries and aquaculture sectors.

In alignment with program-wide gender integration efforts, AquaFish Director, Dr. Hillary Egna, has been a key contributor to raising the importance of equitable gender participation and recognition within AFS and more broadly. AquaFish has sponsored, chaired, and presented at gender research symposia at AFS conferences, and has supported the publication of peer-reviewed papers by gender experts.

AquaFish is thrilled for the launch of GAFS and will continue to support the section's commitment to further gender research and gender-equity practices in aquaculture and fisheries by facilitating equitable and effective exchange of information among scientists and academics, fisheries officers, and non-government organizations.

Be sure to check out the GAFS website for more information on the launch and membership details.

(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 the 6th Symposium on Gender in Aquaculture Forum, held 4–6 August 2016 in Bangkok, Thailand.

Aquaculture Enthusiasts Gather for World Aquaculture 2017

By Lindsay Carroll, *AquaFish Innovation Lab*

AquaFish partners gather at World Aquaculture 2017 (WA 2017), including colleagues from Kenya (upper left, photo courtesy of Elizabeth Obado) and external advisors from Brazil, Ghana, Kenya, and Thailand (lower left, photo courtesy of Charles Ngugi). James B. Mugo also engages with WA 2017 exhibit hosts (right, photo courtesy of James B. Mugo).

Nearly 2,000 aquaculture professionals from all over the world gathered in Cape Town, South Africa in June for the annual conference of the World Aquaculture Society (WAS), World Aquaculture 2017 (WA 2017). AquaFish partners and students from Kenya, Ghana, Uganda, Tanzania, Bangladesh, Nepal, Thailand, Brazil, and the US shared their work among peers across various WA 2017 sessions, including a technical session hosted by AquaFish.

The conference theme, "Sustainable Aquaculture - New Frontiers for Economic Growth - Spotlight on Africa," showcased opportunities for aquaculture production as a mechanism to promote and support economic development in Africa. Taking advantage of the African "spotlight" theme, WAS launched its Africa Chapter, marking a significant milestone for aquaculture in Africa and beyond. At the launch, over 1,200 African members from 33 African countries were recognized and approved to join the chapter. Read more about the launch of the Africa Chapter in the cover story of this issue this issue!

In an effort to increase accessibility to aquaculture innovation and knowledge sharing, participation, and networking, AquaFish collaborated with WAS to provide conference fellowships to five African professionals. The five Africans awarded with the African Professional Fellowship were:

Abudala Napuru, Aquaculture Enterprise Malawi, Malawi

Jean Fall, University Institute of Fisheries and Aquaculture, University of Dhakar, Senegal

Judith Amadiva, Ministry of Agriculture, Livestock & Fisheries Development, Kenya

Margareth Mbwana, Sokoine University of Agriculture, Tanzania

Oludare Akanni Adeogun, Nigerian Institute for Oceanography & Marine Research, Nigeria

AquaFish Director, Dr. Hillary Egna, and Regional Center of Excellence Coordinator for Africa, Dr. Steve Amisah, chaired the AquaFish Technical Session, which provided a forum for AquaFish researchers and students to share research

WA 2017 continued on page 9 ...

... WA 2017 continued from page 8

findings, lessons learned, and much more. The AquaFish session was well-attended and the 20 presenters engaged the audience on a variety of topics including alternative feed methods, women in aquaculture, and methods to increase household nutrition, among others. Check out the full list of presentations and abstracts on the AquaFish Session webpage of the WA 2017 website.

Two presenters of the AquaFish Technical Session were recognized for their outstanding presentation style. Dr. Scott Salger, Postdoctoral Research Scholar from North Carolina State University, was awarded Best Overall Presentation for presenting innovative research titled, "Nutritional control of growth, gut microbiome, and intestinal nutrient transporters in Nile tilapia." Elizabeth Obado, AquaFish Master's student from University of Eldoret in Kenya, was awarded Best Student Presentation for her presentation titled, "The effect of commercial and experimental diets on growth performance of *Oreochromis niloticus* fingerlings reared in hapas suspended in earthen ponds." Dr. Egna said, "Obado showed great poise while answering numerous and challenging questions from the audience."

In addition to the AquaFish Technical Session, Dr. Egna also presented research titled, "Assessing the authorship gender gap in aquaculture-related publications" during the Gender session co-chaired by AquaFish partner, Dr. Shahroz Mahen Haque. Be sure to check out Dr. Egna's abstract as well as the other gender-related presentations on the Gender Session webpage of the WA 2017 website. AquaFish also presented numerous posters highlighting AquaFish's role in advancing climate smart aquaculture and digital and mobile phone technologies, building human and institutional capacity, and engaging African women and youth.

AquaFish was thrilled to take part in the historical milestones achieved at WA 2017. The conference provided an exciting outlet to share research and lessons learned, broaden AquaFish's network, and highlight the expanding potential for aquaculture in Africa. Attendees in Africa and across the world were able to gain inspiration and knowledge necessary to continue tackling global aquaculture challenges.

(Photo Courtesy of Charles Ngugi)

AquaFish awarded five African students with the Best African Student Abstract Award for abstracts that were well written, in alignment with AquaFish's mission and objectives, and demonstrated high scientific merit. The following five students were recognized for their achievement:

Kolawole Akinoshun,
Stellenbosch University, South Africa

Abisola Akinyemi, University of Ibadan, Nigeria

Akua Akuffo, Purdue University, US

Samwel Limbu, University of Dar es Salaam, Tanzania

Gifty Anane-Taabeah, Virginia Polytechnic Institute and State University, US

(Photo Courtesy of Charles Ngugi)

AquaFish partner, Dr. Charles Ngugi, checks out abalone tanks during a WA 2017 field trip.

AquaFish Student Corner

Graduate Student Profile: Touch Nget

By Lindsay Carroll,
AquaFish Innovation Lab

Touch Nget, a Master's student who recently graduated from Royal University of Agriculture in Cambodia (Photo courtesy of Touch Nget).

Cambodian native, Touch Nget, recently graduated with his Master's degree in Aquaculture from Royal University of Agriculture in Cambodia. Nget worked with his advisor, Dr. So Nam, and collaborator, Dr. Nen Phanna, of the Inland Fisheries Research and Development Institute, to further the development of sustainable snakehead aquaculture methods for the lower Mekong Basin in Cambodia and Vietnam, a focus of AquaFish research for over a decade.

Previous weaning and growout experiments determined that non-domesticated snakehead originating from wild Cambodian populations and domesticated snakehead from Vietnamese hatcheries could successfully be cultured using pelleted feed developed by AquaFish. Building upon these efforts, the next phase of research continued to evaluate the growth performance and survival rate of wild and domesticated snakehead strains from Cambodia and Vietnam.

(Photo Courtesy of Touch Nget)

Selection of snakehead broodstock to be used during feeding trials at FARDeC in Cambodia.

Nget was one of two AquaFish students selected to help conduct additional weaning and growout trials on wild and domesticated snakehead strains conducted at the Freshwater Aquaculture Research and Development Center (FARDeC) in Cambodia. "I knew I wanted to conduct an aquaculture experiment, but I didn't know which fish species to focus on," said Nget. "After hearing from Dr. Nen Phanna and Dr. So Nam, I was very interested in the snakehead project," he said.

Snakehead strains used included the first Cambodian strain weaned on Aquafish pelleted feed (F1 generation) and a Vietnamese strain domesticated by Vietnamese partners at Can Tho University (CTU). Wild, Cambodian strains were also collected from the Tonle Sap River and Mekong River.

Results indicated that the snakehead reared from the Vietnamese domesticated broodstock grew over twice as fast as fish reared from all other broodstock of Cambodian origin. Reflecting on his project's successes, Nget said, "we have developed local snakehead strains that [were weaned] on formulated pellet feed, replacing the use of small-sized fish as feed for snakehead aquaculture."

In December 2016, Nget finished his thesis titled, "Comparison of breeding, weaning, and grow-out, performance of different strains of striped snakehead (*Channa striata*) using pellet feed at the FARDeC, Peam Ro District, Prey Veng Province." When asked about his future plans, Nget said, "I want to work as a researcher and technical officer on snakehead aquaculture development to improve snakehead aquaculture and livelihoods of farmers. I want to [continue working on] snakehead genetics to develop a strain with good [growout] performance and disease resistance."

Nget is grateful for AquaFish's support of not only his research, but other Cambodian students as well. He hopes his research will continue to build capacity for farmers and further contribute to snakehead aquaculture development in Cambodia.

AquaFish Alumni Corner

Where Are They Now?: Margareth Kibodya Mbwana

By Lindsay Carroll, *AquaFish Innovation Lab*

A desire to improve the livelihoods of people in rural Tanzania was what originally lured Margareth Kibodya Mbwana to aquaculture, as she recognized its nutritional and economic benefits. "Aquaculture is definitely a way we can produce a high[ly] nutritional food," said Mbwana.

Mbwana first connected with AquaFish in 2008 while earning her Master's degree in Management of Natural Resources for Sustainable Agriculture from Sokoine University of Agriculture (SUA) in Tanzania. With the support from AquaFish and the mentorship of Dr. Sebastian Chenyambuga, Mbwana investigated alternative, affordable, local protein sources for use in Nile tilapia (*Oreochromis niloticus*) culture.

For many years, fishmeal (FM) and soybean meal (SBM) served as primary sources of protein in fish feeds. However, use in small-scale Tanzanian aquaculture was challenging because FM and SBM products were expensive and supply was often limited. To help find alternative, local protein sources, Mbwana evaluated the impact of feeding tilapia leaf meal derived from legume trees.

Leaves and pods from legume trees, specifically *Moringa oleifera* and *Leucaena leucocephala*, are highly nutritious, palatable to animals, and have a well-balanced chemical composition of protein, amino acids, and minerals. Diets formulated with these leaves have proven to be useful feed supplements for animals, including fish. However, information was limited regarding the use in tilapia culture. To address this gap, Mbwana investigated the effects of using leaf meal derived from legume tree leaves in feed on growth performance, feed conversion ratio (FCR), i.e., the rate to which inputs (food) are converted to output (body mass), and survival rate of cultured tilapia.

(Photo courtesy of Margareth Kibodya Mbwana)
Margareth Kibodya Mbwana, AquaFish alumni of Sokoine University of Agriculture in Tanzania.

Tilapia were fed diets formulated with varied protein concentrations of *Moringa oleifera* leaf meal (MOLM), *Leucaena leucocephala* leaf meal (LLLM), and SBM. Results revealed higher growth rate, weight gain, and survival rate for tilapia fed MOLM-based diets compared to LLLM-based diets. An economic analysis suggested that fish fed MOLM- or LLLM-based diets resulted in higher profits, compared to SBM. These findings indicate that MOLM could serve as a cost-effective alternative to SBM in tilapia culture.

In November 2010, Mbwana completed her thesis titled, "Evaluation of *Moringa oleifera* and *Leucaena leucocephala* as protein sources in tilapia diets." Soon after graduating, AquaFish supported Mbwana's completion of the Certification of Aquaculture Professionals (CAP) program, a distance learning opportunity held at Auburn University, an AquaFish partner institution. Mbwana was one of six international scientists selected to complete the course, which was a combination of online, computer-based training and hands-on field experience. This program was a "train-the-trainer" program and participants were expected to disseminate the fundamentals in aquaculture

ALUMNI continued on page 12 ...

AquaFish Alumni Corner

... ALUMNI continued from page 11

they learned by hosting trainings for their peers once back in their home countries.

"I learned a lot of practical skills and knowledge [while] at Auburn," said Mbwana. "I use the knowledge and skills to train more fish farmers in my country, promote women to participate in aquaculture from a primary school level by introducing ponds in schools, [and] increasing motivation to like aquaculture," she said.

Currently, Mbwana works as an Aquaculture Researcher for SUA, where she manages a university fish farm that breeds and rears tilapia and catfish. After graduating with her Master's degree, she was promoted from her Senior Technician position at SUA to her current position, remaining there ever since.

When asked to reflect on her most enjoyable experiences of her AquaFish reseearch, Mbwana proudly said, "When I managed to assemble a tilapia eggs artificial incubator [and] hatched 500 fingerlings used for [my] sex reversal experiment in Tanzania. [This] was the first artificial incubator for tilapia eggs in my country."

Mbwana was also one of five recipients of the African Professional Fellowship, sponsored by AquaFish, to attend the World Aquaculture Society's (WAS) conference held in Cape Town, South Africa, in June 2017. Attending the conference exposed her to global aquaculture innovations, enabled her to expand her network, and broadened her aquaculture knowledge. Be sure to read more about AquaFish's collaboration with WAS to provide professional fellowships, student awards, and more in the WA 2017 article on page 8 of this issue.

(Photo courtesy of Margareth Kibodya Mbwana)
Margareth Kibodya Mbwana pictured with African aquaculture professionals and Dr. Leonard Lovshin at Auburn University in 2011.

Mbwana's desire to improve the livelihoods of Tanzanians continues. She is fueled by her passion for addressing aquaculture challenges facing Tanzania. "We lack the technical know-how of profitable and sustainable fish farming," she said, but, she is excited to see the spread of small-scale fish farms across the country. She hopes to contribute to the expansion of fish farms, as she is currently working to fulfill her dream of having a fish farm of her own. Her plan is to "cross-breed locally available tilapia species to get a fast growing strain resistant to diseases [that is suitable] to our environment," she said. Clearly, Mbwana exemplifies the value of supporting women early in their careers to increase retention in the aquaculture and fisheries sectors.

"With [an] increasing population, climate change, and overfishing in natural water bodies, there is need for using aquaculture knowledge and skills to solve the [fish shortage] problem. I am grateful to AquaFish for supporting and promoting trainings (domestic, regional, and international) for me. I [refer to that] as re-engineering Aquaculture [around] the world."

~Margareth Kibodya Mbwana~

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Linkages and Trust in the Value Chain for Small-scale Aquaculture in Asia (17-376)

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4. Research Center for Marine and Fisheries Socio-economics, Ministry of Marine Affairs and Fisheries, Jakarta, Indonesia

The small-scale aquaculture (SSA) sector is recognized as making an important contribution to food security, poverty alleviation, and socioeconomic development. A value chain analysis can uncover insights into the linkages and trust within a value chain and constraints and challenges that face the sector. This paper examines the linkages and trust between SSA producers and traders in Asia in order to better understand the constraints and opportunities faced by small-scale producers. The perspective revealed by the value chain analysis provides response strategies that can enhance the sustainability and competitiveness of the entire value chain and the actors that comprise it.

This abstract is excerpted from the original paper, which was in Journal of the World Aquaculture Society (2017), 48(4): 542-554.

Weaning methods using formulated feeds for snakehead (*Channa striata* and *Channa micropeltes*) larvae (17-377)

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The culture of snakehead fish (*Channa striata* and *Channa micropeltes*) in Vietnam is limited, and snakehead culture has been banned in Cambodia, because traditional practices include capture of fingerlings from the wild as seed, as well as capture of small-size (also known as trash fish or low-value) fish. As hatchery breeding technology has improved, we investigated the optimal weaning practices for these two species. Both laboratory experiments and farm trials were conducted. For *C. striata*, the optimal weaning procedure is to begin at 17 days after hatch (dah) and wean the fish at 10% replacement of live feed with formulated feed per day. However, for *C. micropeltes*, the optimal procedure is to wait until 40 dah to begin weaning and then to wean the fish with a 10% replacement of live feed with formulated feed every 3 days. These results should enable farmers to domesticate snakehead culture in Vietnam and Cambodia and eliminate reliance on fish captured from the wild as both seed and feed.

This abstract was excerpted from the original paper, which was in Aquaculture Research (2017) 48(9): 4774-4782.

Understanding the Role of Fish Farmer Associations as Intermediaries for the Commercialization of Aquaculture in Uganda (17-378)

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Aquaculture development commentary supports the formation of fish farmer associations or

PUBLICATIONS continued on page 14 ...

... PUBLICATIONS continued from page 13

producer organizations as avenues for cultivating small- and medium-scale commercial farmers. However, little is known about the types of associations that facilitate commercialization. This research presents four qualitative case studies, based on semi- structured interviews, profiling existing associations of commercial fish farmers in Uganda. We conclude that the umbrella organizations under which local fish farmer associations vertically align themselves have important implications for fish farmer production. Aquaculture-specific umbrella organizations contribute to the success of local member association's more than general umbrella organizations do. Successful fish farmer associations accept government assistance only when it directly improves their fish farm operations. Other farmer groups seemed to wait for direct subsidization. Training fish farmers, providing quality information, cost sharing, and advocating for the aquaculture sector, not donor seeking, are the top priorities in productive fish farmer associations.

This abstract was excerpted from the original paper, which was published in Fisheries and Aquaculture Journal (2017) 8(3): 214.

Successful Breeding of Sahar *Tor putitora* in Sub-tropical Nepal (17-379)

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Sahar (*Tor putitora*), also known as mahseer, is an important fish species of the torrential waters of the Himalayas. It is a popular, economically important, and high-value indigenous species. Sahar is a game and food fish that is widely distributed in rivers, streams, and lakes (Rai et al. 1997). The price of sahar in the Nepalese market is almost double that of commonly cultivated carps and tilapia. Sahar is captured from lakes and rivers but commercial cultivation has yet to begin in Nepal. This species is declining in its natural habitat mainly because of urbanization, poaching, overfishing, and ecological alterations of physical, chemical, and biological conditions in the natural environment (Bista et al. 2007). Hence, there is a need for conservation of this species. In recent years, successful artificial breeding at some research stations has led to additional enthusiasm towards developing sahar for commercial cultivation, as well as rehabilitation in natural waters (Rai et al. 2006).

Attempts to culture and conserve sahar were initiated in Nepal, with major efforts to develop culture technology and propagate the species (Gurung et al. 2002, Joshi et al. 2002). This has led to better knowledge of spawning biology, ecology, behavior, and preliminary growth performance in captive conditions. Enhanced growth in tropical and subtropical ponds and recent breeding success in hatcheries has raised new hope for the prospects of sahar aquaculture in Nepal (Shrestha et al. 2005, Bista et al. 2001, 2007, Rai 2008). In addition to the culture of fish to adult size for consumption, these new developments can contribute to rearing individuals that can be stocked into natural waters to replenish populations there. Its omnivorous and predatory feeding habits make sahar a good candidate to co-culture with mixed-sex tilapia to control tilapia recruits and provide better size at harvest and yield of tilapia (Shrestha et al. 2011). Inclusion of sahar in polyculture of mixed-sex tilapia with carps has enhanced overall fish production in these ponds. [Note: The text above is the first two paragraphs of the article].

This abstract was excerpted from the original paper, which was in the World Aquaculture (2017), 48(2): 54-58.

Evaluation of blended virgin coconut oil and fish oil on growth performance and resistance to *Streptococcus iniae* challenge of Nile tilapia (*Oreochromis niloticus*) (17-380)

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Five isolipidic experimental diets (32% crude protein) were formulated to contain 3% fish oil (FO) and virgin coconut oil (3VCO) as sole lipids or blends of FO + VCO in ratios of 75:25% (0.75VCO), 50:50% (1.5VCO) and 25:75% (2.25VCO). Triplicate groups of *O. niloticus* were fed one of five diets to apparent satiation, twice daily for 8 weeks. It was observed that fish fed diet 3VCO exhibited the best performance with respect to feed intake (492.1 g), final weight (214.60 g) and weight gain (154.90 g). Significant effects of dietary fatty

PUBLICATIONS continued on page 15 ...

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acid profile were reflected in fish fed the diets in whole body, muscle and liver C12:0 and C14:0. However, eicosapentaenoic (EPA, 20:5n-3) and docosahexaenoic (DHA, 22:6n- 3) were significantly different (P 0.05) compared to their respective diets while liver n-3: n- 6 ratio significantly increased and recorded low levels in whole body and muscle. Statistically, least values of mortality were recorded as VCO levels were elevated when fish were subjected to Streptococcus iniae infection while plasma metabolite indicators among treatments were not altered. The inclusion of VCO at 3% in the diet gave excellent performance, indicating that it could wholly replace FO and as such represents a better alternative lipid source for feeding *O. niloticus*.

This abstract was excerpted from the original paper, which was in the Egyptian Journal of Basic and Applied Sciences (2017), 4(3): 175-184.

Alternative artificial incubation system for intensive fry production of Nile tilapia (*Oreochromis niloticus*) (17-381)

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Jar incubation system is a well established artificial incubation system for intensive fry production of Nile tilapia. However, this system needs special hatchery structure and huge amount of water for circulation of eggs. The present study aimed to explore a simple, economic and water efficient alternative incubation system appropriate for small-scale hatchery operators. Two incubation systems, i.e. atkin incubation system and aquarium incubation system were compared with jar incubation systems in terms of water use, hatching rate and subsequent survival of larvae. Results showed that the amount of water used was significantly higher in atkin (127.0±3.1 m3) and jar (36.8±4.9 m^3) incubation systems compared to aquarium (0.05±0.0m3) incubation system. The hatching percentage was significantly higher in jar incubation system (95.5±0.6%) compared to aquarium (65.2±7.7%) and atkin (57.8±2.2%) incubation systems. Hatching tended to occur slightly earlier in the jar incubator than other systems. After 7 days of rearing, the mean larval survival rate was highest in jar incubation (96.9±0.5%), intermediate in aquarium incubation (90.9±3.4%) and lowest in atkin incubation (81.0±3.1) system (P<0.05). The dissolved oxygen was significantly higher in aquarium (6.1±0.0 mg/L) than jar (3.0±0.0 mg/L) and atkin (3.0±0.1 mg/L) incubation systems. Further experiments indicated that about 5000 eggs can be successfully hatched with a hatching rate of 95% and reared to swim-up fry in in 50 L size glass aquarium with water exchange twice daily. This system is best suited for incubation of late stage eggs and rearing of newly hatched larvae up to free swimming stage. The results indicate that aquarium incubation can be used as an alternative of jar incubation system for Nile tilapia eggs, especially in water scarce areas.

This abstract was excerpted from the original paper, which was in the International Journal of Fisheries and Aquatic Studies (2017), 5(4): 425-429.

Mud Crab Aquaculture and Fisheries in Coastal Bangladesh (17-382)

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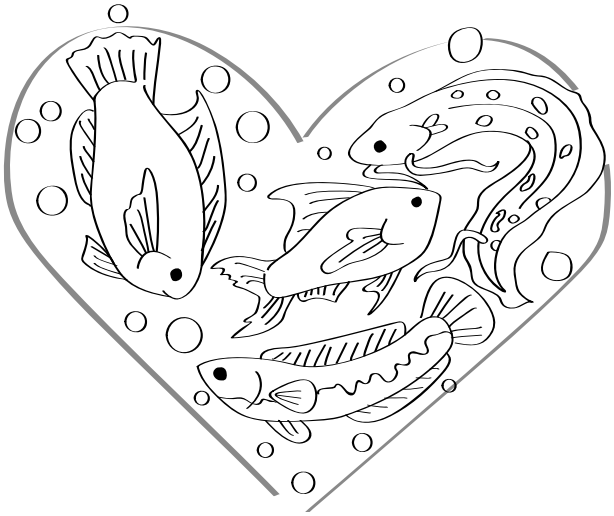
Coastal Bangladesh has the most commercially important species of mud crabs *Scylla spp*., from the family Portunidae (Macintosh et al. 2002). They dig and inhabit burrows in mangrove swamps and shallow, soft- bottom intertidal waterbodies (Quinitio et al. 2008). Mud crabs spend most of their life in estuaries and coastal environments that have mud or detritus, debris of leaves, branches, roots and enough shelter materials or places to hide to avoid cannibalism or to molt. Mud crabs are also known commonly as green crabs or mangrove crabs (Sha and Quddus 1982). Mud crabs are omnivorous or scavengers, feeding on dead animal and plant matter. The 734-km long coastline of Bangladesh, with the world's largest mangrove forest, is a hotspot for diverse aquatic organisms, including mud crabs, providing suitable breeding, feeding and nursery grounds. [Note: The text above is the first paragraph of the article].

This abstract was excerpted from the original paper, which was in World Aquaculture Magazine (2017), 48(2): 47-52.

PONDerings... Art Corner



According to the World Health Organization, regular consumption of fish helps reduce the risk of heart-related illnesses, promotes healthy blood cholesterol, strengthens bones, and builds muscle. Take a moment and color our fish heart (Illustrated by Haley Demmin, AquaFish Innovation Lab).

Upcoming Meetings and Events

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

International Conference on Marine Science & Aquaculture 2018
14-16 March 2018
Kota Kinabalu, Sabah, Malaysia
http://www.ums.edu.my/ipmbv2/icomsa/index.html

Asian Pacific Aquaculture 2018
23-26 April 2018
Taipei, Taiwan
https://www.was.org/

Global Summit on Aquaculture and Fisheries
24-25 May 2018
Osaka, Japan
https://aquaculture.global-summit.com/

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

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

9th International Conference on Fisheries and Aquaculture
17-19 September 2018
Vancouver, British Columbia, Canada
https://fisheries.conferenceseries.com/3rd

Aquaculture Conference
25-28 September 2018
Qingdao, China
https://www.elsevier.com/events/conferences/aquaculture

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

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Are you a current AquaFish Innovation Lab student or a former AquaFish, ACRSP, or PD/A CRSP student? Do you have story ideas or photos you want to send to us? Email us your story suggestions and photos for consideration to aquafish@oregonstate.edu.

Parting shot

(Photo courtesy of AquaFish Innovation Lab)

AquaFish reels in Oregon State University faculty and staff at Annual University Day Expo.

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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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AquaNews is published by the AquaFish Innovation Lab, Oregon State University, Corvallis, OR 97331, USA.
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The Feed the Future Innovation Lab for Collaborative Research on Aquaculture & Fisheries is funded under USAID Leader with Associates Cooperative Agreement No. EPP-A-00-06-00012-00 and by the participating US and Host Country partners. The contents of this newsletter are the responsibility of the authors and do not necessarily reflect the views or endorsement of USAID or the United States Government.