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COMMERCIALIZATION AND ADOPTION OF SNAKEHEAD FEED

By Matt Berger, AquaFish Innovation Lab



Snakehead harvest in Cambodia (photo courtesy of AquaFish HC Investigator Dr. Prum Somany).

In the Mekong Delta, thousands of tons of low-value freshwater fish are harvested as feed for farmed-raised snakehead, pangasius, basa, and giant prawn each year. This pressure on wild fish stocks – and thus lower availability of those fish for more traditional uses, such as fish sauce – contributed to the Cambodian government's decision to ban snakehead farming in 2005.

In neighboring Vietnam, however, snakehead farming is still allowed, despite the same negative ecological impacts on the populations of small-sized fish. Since most snakehead aquaculture occurs in the Mekong Delta,

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STRATEGIES FOR REDUCING FEED COSTS IN SMALL-SCALE AQUACULTURE

By Caleb Price and Dr. Hillary Egna, AquaFish Innovation Lab



Demonstration of sustainable feed production (photo courtesy of AquaFish Innovation Lab).

The rapid growth of the global aquaculture industry has increased demand for processed fish feed and its components, and an increase in the market price of these ingredients has had a significant impact on the operating costs of aquaculture throughout the world. Reasons for increases in prices for the inputs on which aquaculture depends, such as cereals and fishmeal, include reductions in the amount of available land for cultivation; increasingly adverse and unpredictable weather conditions; stockpiling of grains and other ingredients used in aquafeeds; and upward pressure on supplies prompted by competition between the aquaculture and animal husbandry sectors, as well as other non-traditional uses for these commodities.

Volatility in the prices of fishmeal and other globally traded commodities, particularly crops like wheat and maize, places a heavy burden on developing-country farmers whose livelihoods depend on aquafeed made with these ingredients. In many of these small-scale operations, feed can account for 80% or more of total production costs. When faced with an increase in feed costs, many poor farmers may

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Goings-On in the Pond...



AquaFish Management Team (MT) presented current work at Oregon State University's annual University Day on 18 September 2014 at the CH2M HILL Alumni Center. New OSU faculty and students learned about AquaFish projects and fun facts about aquaculture, fisheries, and international development.

The AquaFish 8th Annual Report was recently completed and released to the general public on the AquaFish website with updated information on projects and country involvement. The report can be found at www.aquafishcrsp.oregonstate.edu/Documents/Uploads/FileManager/Eighth_Annual_Report.pdf

Dr. Emmanuel Frimpong, AquaFish US Co-PI and Associate Professor of Fisheries Science in the College of Natural Resource and Environment at Virginia Tech, was named a Carnegie African Diaspora Fellow in October 2014. The prestigious award is limited to African-born individuals that work in higher education in the US and Canada. The award will allow Dr. Frimpong to spend more time in his native Ghana, collaborating with the Kwame Nkrumah University of Science and Technology (KNUST) on aquaculture, fisheries, and water resource management curricula and also to continue research on aquaculture.



Fish pond in Tanzania (photo courtesy of AquaFish Innovation Lab).

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Snakehead processing in Cambodia (photo courtesy of AquaFish HC Investigator Dr. Prum Somany).

a partial solution was to develop a more vegetable-based feed for use in snakehead aquaculture.

From 2007 to 2012, AquaFish coordinated research in Vietnam to accomplish just that, eventually creating a formulated feed with minimal fishmeal content – replaced by soybean, rice bran, and cassava meal – on which snakehead can be raised without impacting their growth or market quality. The research took place at Can Tho University in Vietnam, with assistance from University of Rhode Island collaborators. Multiple combinations of fishmeal and vegetable-based substitutes were tested for their effects on snakehead growth and quality, eventually resulting in a feed that was able to replace 10% of the fishmeal for the first 30 days after hatching and 40% thereafter.

In the years since the completion of the AquaFish-led research, commercialization of the new pellet feed has taken off. In the Vietnamese Mekong Delta provinces where the research was focused – An Giang, Tra Vinh, Vinh Long, and Dong Thap – nearly all of the snakehead farmers (approximately 99%) now use pellet feeds developed by AquaFish, according to Tran Thi Thanh Hien, a researcher on the AquaFish-led project.

After initial development, the “AquaFish CRSP diet” was distributed to just three farmers in specially labeled bags in the hopes that they would demonstrate the economic and environmental benefits of the product. Meanwhile, workshops were held to reach additional farmers and research results were distributed to feed manufacturers.

The outreach efforts paid off and currently 14 feed producers are supplying the new pellet feed to more than 3,500 farmers. Farmers have switched to the feed for different reasons – some because it is less expensive than what they were using, others because they saw increases in the growth rate of the fish. Whatever the reason, it is evident that AquaFish researchers were successful in developing an economically competitive and effective alternative feed that decreases reliance on wild fish populations.

This work provides a solid foundation with which to expand, and Hien and her colleagues believe they “can [spread] the commercialization of the feed into other countries [and] apply these results into formulating pellet feeds for other carnivorous farmed fish.”



....Strategies continued from page 2.

have no other choice than to stop feeding their fish.

With its partner institutions, AquaFish Innovation Lab seeks to provide better options for small-scale fish farmers who are vulnerable to fluctuations in feed costs. AquaFish researchers develop technologies for reducing feed costs based on two main methods: feeding less and feeding differently.

Naturally, feeding less while still achieving comparable yield is challenging. In 1982, the Pond Dynamics/Aquaculture Collaborative Research Support Program (PD/A CRSP) began researching methods for optimizing pond productivity for growing fish to market size. Researchers from the US partnered with scientists at the Asian Institute of Technology in Thailand to develop a unifying strategy for optimizing pond production systems. Pond fertilization has long been practiced throughout the world in the culture of planktivorous fishes to increase overall yield. When carefully managed, a pond can provide naturally produced food items to fish, thereby reducing the need for supplemental feeding. This approach to optimizing pond production is a best management practice referred to as “greenwater technology” by AquaFish because of the color of phytoplankton blooms in fishponds, indicating a high level of primary productivity.

AquaFish researchers found that when farmers used greenwater technology in the correct conditions, production could reach up to 7000 kilograms of fish per hectare per year (kg/ha/yr). Furthermore, a culture operation that uses supplemental feeds in addition to naturally produced in-pond food items can increase yields well above these production levels – up to 30,000 kg/ha/yr, surpassing farms that spend much more on feed inputs. This approach is not only more cost-effective with higher net revenues, but it is also more sustainable, because it reduces the amount of eutrophic effluent entering the surrounding environment.

Feeding can also mean feeding fish on alternate days. Some fish farmers can

effectively cut feed costs in half while dramatically increasing the feed-conversion ratio (FCR) of the fish crop. Dr. Remedios Bolivar from Central Luzon State University in the Philippines conducted feed trials in a collaborative research effort with scientists from North Carolina State University and Florida International University. This research compared tilapia (*Oreochromis niloticus*) reared in freshwater ponds and fed on alternate-days with fish fed a normal daily ration, as well as milkfish (*Chanos chanos*) raised in marine cages and fed on alternate days with fish fed a normal daily ration. The alternate-day feeding regime for tilapia and milkfish achieved cost savings of 30-40% for both species. This simple technology is easy to implement and requires very little training, making it an ideal option for small-scale farmers vulnerable to increases in feed costs or in areas suffering from eutrophication.

Another method for reducing feed costs is to feed fish differently during grow-out by utilizing product substitutions in feeds (alternative sources for feed ingredients), increasing the nutritional content of feed, and improving locally produced, low-cost feeds through pelletization. In Tanzania, fish farmers rely largely on naturally available feeds for supplementing the primary productivity of aquaculture ponds, including rice, maize bran, kitchen scraps, and garden cuttings. The lack of proper nutrition in these types



A fish farmer weighs his Tilapia Grower Feed in the Philippines (photo by Remedios Bolivar).

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VALUE CHAIN ANALYSIS HELPS OVERCOME GENDER BARRIERS IN AQUACULTURE

By Paris Edwards and Dr. Hillary Egna, AquaFish Innovation Lab

Successful aquaculture supply chains require access to market information, reliable transportation, good communication and relationships, and access to technology. Value chain analysis (VCA) is one tool that can be used to improve the efficiency and equity of these supply chains.

Value chains are complex, and VCA studies in aquaculture look at both the economic and social elements of the value chain, focusing on where value can be added. This increases transparency and opens opportunity for economic improvements to quality, processing, safety, and value-added products. Attention is also paid to who is involved along the chain, the intricate relationships between linkages, and how individuals and groups stand to benefit or be harmed. With a more thorough understanding of all reference points along the aquaculture value chain, opportunities arise for improved performance of the entire aquaculture sector.

Understanding value chains can also help uncover where women are involved and how they can benefit or be harmed by interventions

along the chain. Both women and men are vital to the viability of the aquaculture industry in developing countries; gender integration is essential for the successful growth of the sector. In developing countries, women produce over half the food, bear most of the responsibility for household food security, and increasingly contribute to the household through income generating activities. In recent years, women's involvement in agriculture activities has expanded to meet increasing global food production demands. However, their roles are limited by lack of access to economic opportunities, education, capital, and technology. Typically, they are not equally represented along value chains; rather they tend to be concentrated in high-risk and low-power positions in the middle.

AquaFish, partnered with collaborating institutions throughout the world, has conducted several research investigations using VCA as a tool to increase income and nutrition for small-scale fish farmers through improved market participation and efficiency. AquaFish's work in Africa and Asia has identified some of the underlying barriers to women's participation and has subsequently begun to develop strategies for overcoming them.

From 2009 to 2012, AquaFish partnered with Purdue University, Kwame Nkrumah University, Moi University (now University of Eldoret), and the Ministry of Fisheries Development in a VCA

Value Chain continued on page 6...



Women fish traders at Lake Victoria
(photo courtesy of AquaFish Innovation Lab).

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and consumer preference study to ascertain the roles of women in aquaculture in Kenya and Ghana.

In response to dwindling wild fish stocks and the resulting economic impacts, project partners held a workshop for women wild fish traders in Mumias, Kenya, in November 2010 to provide information on crossing over to aquaculture. The aquaculture industry in Kenya is growing rapidly, and women can improve their economic welfare by increasingly entering the chain as fish farmers and hatchery producers. Major roles in the value chain include input suppliers, suppliers of juvenile seed fish, fish farmers, and fish marketers.

Concurrent research was conducted in Ghana to assess the value chain of farmed tilapia. The study showed that women dominate fish processing and, in this role, interact with all of the key value chain actors including the traders and consumers. The women involved are mostly enterprising individuals accountable to themselves, but some work in groups and provide their services together at markets. The study suggests that growth in the sector is expected to increase opportunities for female processors, but communication and safety must be improved in order to ensure benefits from this growth. Organizing into cooperative groups is one suggested method to help both processors and consumers gain better access to government assistance meant to support the growing aquaculture industry. As demand for fish increases and more safety standards are required, these cooperative groups will have better access to opportunities and technologies in processing as well as sanitation for personal protection and food safety.



Seaweed farmers learn new ways to market seaweed aquaculture products through cooking, drying, and other forms of processing at workshop in Banda Aceh, Indonesia (photo courtesy of AquaFish Innovation Lab).

AquaFish research conducted in the rural northwestern province of Aceh, Indonesia, between 2009-2013 combined VCA and technical trainings to successfully introduce seaweed farming to communities recovering from a 2004 tsunami that devastated shrimp aquaculture in the area. Research efforts also addressed the challenge of rebuilding shrimp aquaculture with a renewed focus on sustainability. Training activities focused on best management practices for small-scale tambak ponds through seaweed and shrimp polyculture. What began as restoration assistance by cultivating seaweed (*Gracilaria*) for pond effluent removal, grew to a broad VCA of the seaweed markets of Indonesia and a series of workshops to enhance the benefits of growing and selling seaweed.

Indonesia is one of the world's largest exporters of agar, a seaweed byproduct used throughout the food industry and in pharmaceuticals as a thickener and stabilizer. AquaFish conducted a VCA of the seaweed market in Aceh in response to growing demand in the ports of Jakarta, Sulawesi, and Surabaya, the major transshipment points of tradable seaweed products. The study looked at the roles of key players in the industry, logistics, and transaction flows between market levels, and external market influences. The results suggest that communication about product quality standards and adequate facilities for optimal drying are some of the major barriers for building successful relationships between rural farmers and professional buyers.

In response, AquaFish partners reached more than 220 farming families through nine workshops to teach men and women how to farm, dry, and process seaweed for optimal sale quality. One such

Value Chain continued on page 8...

AQUAFISH STUDENT CORNER

GRADUATE STUDENT PROFILE: IRIS FYNN

By Morgan Chow, AquaFish Innovation Lab



Iris Fynn surveys a pond in Ghana (photo courtesy of Iris Fynn).

Aquaculture in Ghana is helping to narrow the gap between domestic seafood production and consumption. Iris Fynn, a Master of Science candidate at Virginia Tech, is working to identify suitable aquaculture areas throughout Ghana by linking spatial information for aquaculture ponds with socioeconomic data. This information will be used by the Ministry of Fisheries and Aquaculture Development of Ghana to develop priority aquaculture areas for the country.

Under the supervision of Dr. Emmanuel Frimpong, Iris's efforts will cross-validate existing data on production and pond systems in Ghana while also relating pond distribution and production levels to site suitability indices previously developed by the United Nations Food and Agricultural Organization (FAO). Through this research, Iris is trying to accurately estimate the total volume of production from ponds in Ghana.

So far, Iris has identified the key infrastructure that is relevant for the progress of aquaculture

development in Ghana as well as verified the presence of reported farms. Her maps describe the characteristics of the required infrastructure, and illustrate variations among fish ponds throughout the country. She also plans to create maps that highlight the relative advantages of regions in the country for aquaculture and their potential for increased production to accelerate development of pond aquaculture. Once all of her work is complete, Iris will share her findings with the Ministry of Fisheries and Aquaculture Development.

While pursuing a Bachelor's of Science in Natural Resources Management from the Kwame Nkrumah University of Science and Technology (KNUST) in Kumasi, Ghana, Iris became aware of declining conditions of watersheds throughout the country. Much of this was due to land development and fish harvesting strategies that had little regard for sustainable resource use. Iris became interested in aquaculture due to its potential to reduce stress on wild fish

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AQUAFISH STUDENT CORNER

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Iris poses in a pond site Ghana while taking samples (photo courtesy of Iris Fynn).

stocks and contribute to food security. She chose to pursue a Master's Degree in Fish and Wildlife Conservation to help combat barriers to sustainable aquaculture, such as mismanagement and lack of awareness, and offer appropriate and effective solutions to help her native Ghana.

Iris was also involved in AquaFish's Strategic Investment in Rapid Technology Dissemination (SIRTD) Associate Award that focused on enhancing profitability through the development and implementation of best management practices (BMPs) in Ghana, Kenya, and Tanzania. As part of this project, Iris helped survey approximately 400 farmers about socioeconomic conditions. The work provided solid baseline data for continued development and evaluation of aquaculture BMPs in sub-Saharan Africa.

Iris hopes that her completed research will provide a "one-point access to vital information" regarding fish pond locations, markets, input supplies, and extension services. She is expecting to complete her degree in December 2014 and would like to teach at a university, as well as collaborate with other research institutions, fisheries departments, and farmers throughout Ghana.



...Value Chain continued from page 6.

workshop taught farmers how to construct drying racks from local materials to maintain quality for profitable, high-grade agar production. Additional workshops taught women recipes and nutritional benefits of cooking with *Gracilaria*. More than 100 farmers adopted seaweed polyculture in Aceh. Thanks to the efforts of AquaFish researchers and partners, this budding new seaweed market is contributing to more sustainable shrimp farming and has become a promising new source of income generation and nutrition in rural Indonesia.

Gender integration in value chains represents an important innovation in our understanding of the significant roles women play in the health of households, economies, and aquaculture development. This awareness, along with the early VCA efforts described above, inspired AquaFish's leadership in the first globally focused meeting on gender equity in aquaculture value chains. Three special sessions on markets and value chains for small aquaculture and fisheries enterprises with a focus on gender were held at the 16th Annual International Institute of Fisheries Economics and Trade Conference (IIFET) in 2012. The sessions helped bring gender integration to the forefront of VCA efforts. These sessions included 17 presentations, representing many different streams of scholarship from around the globe attempting to understand the complex relationships that influence market performance for smallholder farmers, including value-added distribution, optimal institutional arrangements, and policy approaches. Common patterns emerged among the presenters, such as the observation of a concentration of less educated, resource poor women at the low-value end of chains.

Thanks to efforts like these, VCA will continue to be a key tool used by AquaFish to enhance aquaculture markets and benefits such as nutrition and income in developing nations.

* A version of this article originally appeared in the September-October 2014 issue of The Advocate, published by the Global Aquaculture Alliance.



AQUAFISH ALUMNI CORNER

WHERE ARE THEY NOW:

TRAN THI BE

By Matt Berger, AquaFish Innovation Lab

Aquaculture can often relieve pressure on wild fish stocks for many species. However, when raising carnivorous fish, wild fish are often harvested to feed the farmed fish. Be Thi Tran understood these complexities as a young student at Can Tho University in Vietnam and devoted her studies to developing new and more affordable formulated feeds.

While pursuing her Master's degree at Can Tho University, Be worked on developing new feed formulas for snakehead, a widely farmed but carnivorous fish in Vietnam and Cambodia. Her research focused on supplementing snakehead diets high in plant protein with phytase and taurine to develop feeds that would reduce dependence on wild-caught fish.

Be's work was part of an AquaFish-funded effort in cooperation with Can Tho University and the University of Rhode Island that successfully developed a formulated pellet feed. This new feed replaced 10% of wild fish in snakehead feed for the first 30 days after hatching, and 40% thereafter. This pellet feed, and others like it, have now been adopted by thousands of snakehead farmers in Vietnam. (See "Commercialization and Adoption of Snakehead Feed" page 1.)

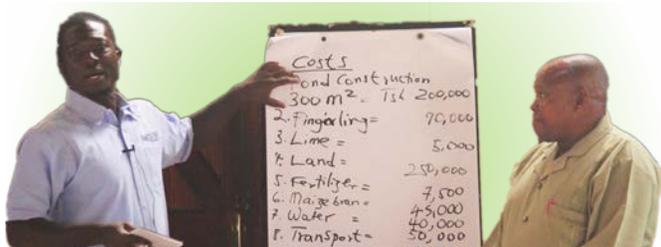
Be's Master's work with AquaFish created a solid foundation on which she continues to build her career. She is now a PhD student at Can Tho, continuing her mission of developing more efficient fish feeds. This time, she is focusing on the mudskipper (*Pseudapocryptes elongates*), an amphibious, air-breathing fish whose popularity as a high-value aquaculture species has skyrocketed in the Mekong Delta in the past decade. She also teaches classes, passing on her knowledge of sustainable, efficient aquaculture practices to the next generation of researchers.



Tran Thi Be rears Snakehead in Vietnam (photo courtesy of Tran Thi Be).

BEST MANAGEMENT PRACTICES WORKSHOP, TANZANIA

By Morgan Chow, AquaFish Innovation Lab



Virginia Tech PhD student, Yaw Anseh, discusses main input costs for tilapia farming (photo courtesy of AquaFish Innovation Lab).

In August 2014, AquaFish partners from Kenya, Ghana, and Tanzania trained Tanzanian farmers in aquaculture best management practices (BMPs). More than 40 people from all over Tanzania participated in the two-day workshop in Morogoro, Tanzania, on 5-6 August 2014, as part of the final SIRTID (Strategic Investment in Rapid Technology Dissemination) training event. The topics of the training included water quality management, fertilization strategies, pond dynamics, fingerling transport, feed formulation, and the role of plankton in aquaculture. This workshop was unique in that experts from all three participating countries of the SIRTID Associate Award were present to contribute their extensive knowledge of BMPs in pond aquaculture. The SIRTID project, which began in 2010, focused on BMP adoption to provide economic, environmental, and agronomic efficiency for aquaculture in sub-Saharan Africa.

A workshop participant examines plankton from a water sample taken from a SUA pond (photo courtesy of AquaFish Innovation Lab).



Workshop participants included small-scale farmers, fisheries officers, extension officers, and academics. In addition to teaching core aquaculture principles, the trainers -- AquaFish SIRTID personnel and students -- also covered farm and nursery management. The workshop provided trainees with hands-on demonstrations of BMPs. Trainees learned how to make extruded feeds and examined pond-water plankton samples under microscopes at the Sokoine University of Agriculture (SUA) wet lab to learn about the role of plankton in aquaculture.

Overall, the sessions were very well-received by the participants, and workshop leaders were successful in demystifying BMPs for farmers. Workshop trainers learned to be flexible in presenting material consistent with their audience's fish farming experience. This workshop, one of 14 supported by the SIRTID Associate Award, helped to strengthen regional coordination of aquaculture practices throughout Tanzania, Kenya, and Ghana, and promoted knowledge dissemination among Tanzanian farmers.



AquaFish Innovation Lab Best Management Practices (BMP) Workshop participants gather outside the venue in Morogoro, Tanzania (photo courtesy of AquaFish Innovation Lab).

STRATEGIC INVESTMENT IN RAPID TECHNOLOGY DISSEMINATION ASSOCIATE AWARD CLOSEOUT MEETING, TANZANIA

By Morgan Chow, AquaFish Innovation Lab



Ford Evans, AquaFish Management Team, and HC Co-PI Charles Ngugi discuss SIRTD outcomes (photo courtesy of AquaFish Innovation Lab).

Listen up! -- This is the beginning statement of a radio sound bite on aquaculture best management practices (BMPs) that will broadcast throughout Ghana. This is just one of many outreach efforts under way as part of the Strategic Investment in Rapid Technology Dissemination (SIRTD) Associate Award, titled *Enhancing the Profitability of Small Aquaculture Operations in Ghana, Kenya, and Tanzania*.

The SIRTD project focused on adoption and dissemination of BMPs to promote agricultural growth through increased productivity, expanded markets and trade, and increased economic resilience across sub-Saharan Africa. Dissemination was accomplished in three ways: 1) Central media -- regional workshops and other diffusion techniques; 2) Demonstrations of BMPs at selected farms; and 3) Lateral diffusion -- farmer-to-farmer extension of BMPs.

The closeout meeting, held in Tanzania on 7-9 August 2014, served as an opportunity for partners from the three focus countries to collaborate on outreach projects, final reporting requirements, and project deliverables.

The SIRTD project focused on the adoption of two technologies: better effluent management through pond-water reuse, and nutrient management through improved feeding

strategies, feed types, and fertilization. However, meeting participants went further to identify 10 BMPs, and discussed which BMPs were most relevant for each country. Differences in how each participating country prioritized BMPs marked important distinctions in the level of development of aquaculture practices among Ghana, Kenya, and Tanzania.

Project partners shared successes and lessons learned from four years of work. "Pond fertilization strategies -- green water technology -- was already developed and tested worldwide when this project began in 2010. We wanted to use what we know would work, and has worked in Asia and Latin America, in Ghana. Then we wanted to transfer successful behavior communication strategies from Ghana to the other two countries involved in this project -- Kenya and Tanzania," says Dr. Hillary Egna.

In Kenya, farmers adopted the water reuse BMP at a rate of 27%, and the improved feeds technology was adopted at a rate of 23% between 2012 and 2014. In Ghana, researchers found that the water reuse BMP was adopted at a rate of 25% during the life of the project, and floating feed use was adopted at a rate of 31% over the same time. Notably, the water reuse technology was not practiced in Ghana before this project. The widespread adoption of this BMP represents a significant step towards sustainability for small-scale fish farming in the country.

In addition to the outreach materials produced during the project, partners are developing radio sound bites, informational calendars, and posters, to further disseminate BMPs. With the help of these efforts, and through farmer-to-farmer dissemination, project partners anticipate that profitability of these technologies will continue to provide benefits to BMP adopters in the three project countries well into the future.

10 BMPs:

1. No draining of ponds;
2. Surface draining if necessary;
3. Detain water when draining ponds;
4. Drain into wetlands to reduce effluent nutrients;
5. Capture and store rainfall;
6. Use high-quality feeds;
7. Do not overstock fish;
8. Avoid flushing or water exchange;
9. Use effluent for irrigation, if possible;
10. Practice erosion control during pond renovation.

CHAZA COOPERATIVE SOCIETY, ZANZIBAR, TANZANIA

At the Chaza Cooperative Society (CCS), a women-run oyster cooperative, members take part in every aspect of oyster management -- from the implementation and monitoring of no-take zones, to the harvest and processing of oysters. Efforts are aimed at conserving shellfish resources while providing alternative income to women through pearl farming, crafting shellfish jewelry, and other activities.



CCS members display value-added shell products, including jewelry made from oyster shells and pearls.



CCS members and AquaFish Management staff gather in front of the CCS building.



Tanzania investigator Dr. Nari-man Jiddawi reads a book with local school children.



CCS member explains how their group monitors oyster growth and survival with transect lines and quadrats.

....Strategies continued from page 4.

of supplemental feeds means the fish are malnourished in comparison to a properly balanced, nutrient-rich diet. To address this problem, Dr. Sebastian Chenyambuga and researchers from Sokoine Agricultural University in Tanzania partnered with scientists at Purdue University and the University of Arkansas at Pine Bluff to develop alternative protein sources for tilapia diets using two native tree species, *Moringa oleifera* and *Leucaena leucocephala*. After conducting on-farm trials using protein substitutes derived from nutrient-rich leaf meals of these two trees, researchers found that fish fed with Moringa leaf meal grew at the same rate as fish fed with soybean meal. This research helped create options for small-scale farmers who can use this widely available, native tree species to improve their supplemental fish feed while improving the health and growth of their crop.

In neighboring Kenya, a lack of quality pelleted-feeds is a primary constraint to the aquaculture industry, and a chief determinant of the ability of small-scale fish farms to generate income for households. The AquaFish Innovation Lab is sponsoring research led by Dr. Charles Ngugi from Kenyatta University, in partnership with scientists from Eldoret University and the University of Arizona, to develop a practical tilapia feed from locally available ingredients using feed formulation software. But simply determining ideal formulations will not necessarily improve FCRs at fish farms. To help reduce feed waste and improve feeding efficiency, the research team will obtain a low-cost grinding mill, mixer, and pelletizer to make pelleted feed using the formulation they develop. This approach presents a good alternative to importing costly commercial feeds, as pelletizing feeds is expected to increase fish production at participating farms by at least 10% and improve FCRs by 50%.

Both small-scale and commercial aquaculture make important contributions towards meeting the growing global demand for seafood products. In developing nations, small-scale aquaculture is an essential tool for ensuring food security and income

generating opportunities for the poor. By providing small-scale fish farmers with alternatives to purchasing expensive feeds, the AquaFish Innovation Lab is helping vulnerable populations combat the rising costs of fish feeds, and ultimately building pathways out of poverty for poor fish farmers throughout the world.

* A version of this article originally appeared in the May-Jun 2014 issue of The Advocate, published by the Global Aquaculture Alliance.



PONDERINGS...

Big fish and small fish
Swimming here in this pond
Fast fish and slow fish
And now one is gone

Poor, foolish fishes
Just make a few stronger
And watch how these fishes
Devour each other

To be the small fish
I'm sure none would bother
But oh, don't you wish
You could make the pond
smaller?

I've found my own niche
To live my life fuller
For I am a fish
Of a different color

-Cory Fox

Notices of Publication

Notices of Publication announce recently published work carried out under AquaFish sponsorship. To receive a full copy of a publication, please contact the author(s) directly. All past and present Notices of Publication can be found on the AquaFish website at: aquafishcrsp.oregonstate.edu/nops.php

Consumer Perceptions and Preferences of Wild and Farmed Nile Tilapia (*Oreochromis niloticus* L.) and African Catfish (*Clarias gariepinus* Burchell 1822) in Urban Centres in Kenya (14-327).

Cecilia Muthoni Githukia, Julius O. Manyala, Charles C. Ngugi, and Kwamena K. Quagrainie.

Past fish production research done in Kenya suggests a strong production focus, leaving many fish consumer and marketing questions unanswered. This study investigated consumer fish preferences and trends in demand for Nile tilapia and African catfish in five urban centres in Kenya. A total of 384 questionnaires were administered to fish consumers and retailers in open markets, supermarkets, hotels and landing beaches. Descriptive and inferential analyses were done using SPSS Version 20.0. Female consumers were significantly higher ($p > 0.05$) in all study areas except Nairobi. There were significant differences in levels of preference for either the wild and farmed Nile tilapia ($p > 0.05$). Main reasons for consuming fish by consumers were health benefits of fish, good taste and ease of cooking. Quantities of fish purchased by consumers was generally small ranging from 1.68 ± 0.20 kgs in Kisumu to as low as 0.30 ± 0.04 kgs in Nyeri. The main factors affecting consumer preference of Nile tilapia fish were price, overall fish quality, nutritional value, and healthiness. In order to promote preference and consumption of farmed fish in Kenya, the government should educate consumers about the safety, healthiness and nutritional value of aquaculture products.

This abstract was excerpted from the original

paper, which was published in the International Journal of Advanced Research (2014), 2(7): 694-705.

Value Chain of Snakehead Fish in the Lower Mekong Basin of Cambodia and Vietnam (14-328).

Le Xuan Sinh, Hap Navy, and Robert S. Pomeroy.

Snakehead fish are the most preferred fish species for food in Cambodia and Vietnam, and are consumed in both fresh and processed forms. The purpose of this paper is to describe the value chains of captured and cultured snakeheads in the Lower Mekong Basin (LMB). The important actors involved in the value chain of snakeheads in the LMB of Cambodia and Vietnam were fishers, fish farmers, wholesalers, retailers, and processors. The value chain of wild captured snakeheads in Cambodia was focused on 11 marketing channels, and for cultured snakeheads in Vietnam, 10 market channels. The distribution of benefits among the chain actors was unequal, with the highest proportion of profit going to wholesalers in Cambodia and collectors in Vietnam. In order to develop the value chain of snakehead for the long-term in the LMB, appropriate plans must be prepared for each country in association with better management and protection of natural aquatic resources.

This abstract was excerpted from the original paper, which was published in Aquaculture Economics & Management (2014), 18(1): 76-96.

Investigations of types of products from snakehead fish (*Channa striata*) and their production process in An Giang province (14-329).

Bui Phuong Dai, Truong Thi Mong Thu, and Tran Thi Thanh Hien.

This study aimed at investigating the types of products from snakehead fish and technological processes for manufacturing these products in An Giang province. It has

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three main contents including (i) production situation and technological processes for manufacturing the products; (ii) investigating types of products; (iii) trade situation in the markets and customer tastes for the products. The results showed that (i) relatively good technological processes and good quality products were almost from processing facilities that operated longer than 20 years. However, these facilities primarily produced by traditional methods which could only meet the requirement of domestic customers without reaching food safety and hygiene standards for export; (ii) products from snakehead fish primarily were dry salted snakehead fish and salty fermented snakehead fish; (iii) consumption of these products were at the medium level because of high price. Customers aged 30-40 liked eating salty fermented snakehead fish while customers aged 20-30 liked eating dry salted snakehead fish. When buying these products, customers paid attention to quality, safety, hygiene, brand name and price of the products.

This abstract was excerpted from the original paper, which was published in Can Tho University Journal of Science (2014), 1: 36-41.

Assessment on production efficiency and weather change impacts on snakehead pond culture in An Giang and Tra Vinh provinces (14-330).

Tran Hoang Tuan, Nguyen Tuan Loc, Huynh Van Hien, Truong Hoang Minh, Tran Ngoc Hai, and Robert S. Pomeroy.

This study was conducted by interviewing 64 snakehead farmers (pond culture) in An Giang and Tra Vinh provinces from February to April 2014. The results showed that farm scale in An Giang province was smaller than that in Tra Vinh province, the source of snakehead fingerling was mainly from hatcheries in An Giang. Pellet feed was used in snakehead farming with FCR: 1.32-1.33. Culture period, survival rate and yield were not significantly different between the two provinces; harvest size in Tra Vinh was larger than that in An Giang. Total cost of fish culture was rather high

(4.9-5.8 VND billion/ha/crop), ratio of gained profit households in Tra Vinh and An Giang were 15.6% and 37.5%, respectively due to low farm gate price. Weather changes were effected snakehead pond culture such as (prolong hot and drought, hotter in dry season, large temperature variation between day and night, colder in cold season, irregular rain and sunshine and saline water intrusion caused more diseases, poorer water quality, reduced survival rate and yield. Farmers' adaptive solution was increase the cost of water plumbing and using chemical- drug 24.2 - 29.2 VND million/ha/year.

This abstract was excerpted from the original paper, which was published in Can Tho University Journal of Science (2014), 2: 141-149.

Replacing fishmeal by some of soy protein sources in feed for snakehead (*Channa striata*) (14-331).

Tran Thi Thanh Hien, Tran Le Cam Tu, Nguyen Vinh Tien, Nguyen Bao Trung, Tran Minh Phu, Pham Minh Duc, and David Bengtson.

The study was conducted to determine the appropriate replacing of fish meal (FM) protein by three type's soybean meal: defatted soybean meal (SB), fermented soybean meal (FSB) and soy protein concentrate (SPC) in snakehead (*Channa striata*) diet. Four isonitrogenous (45%) and isocaloric (4.6 Kcal/g) diets were formulated. The control diet was prepared with 100% FM protein. Three other diets was replaced 40% FM protein by three type's soybean meal protein. Results showed that there was no significant difference in survival rate between feeding treatments. Fish growth performance in control diet and diet replaced SPC were significantly higher than the diets replaced SB and FSB. Food intake observed in diet replaced SPC treatment was not significant difference compared to control treatment. There was no significant difference between treatments in Feed Conversion Ratio, Protein Efficiency Ratio and hematological parameters (red blood cells and white blood cells). Hepatosomatic Index calculated in control treatment was significantly higher

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than those of others. Thus, it can be replaced 40% fish meal (FM) protein by soy protein concentrate (SPC) in snakehead (*Channa striata*) diet.

This abstract was excerpted from the original paper, which was published in Can Tho University Journal of Science (2014), 1: 310-318.

Effects of Two Environmental Best Management Practices on Pond Water and Effluent Quality and Growth of Nile Tilapia, *Oreochromis niloticus* (14-332).

Emmanuel A. Frimpong, Yaw B. Ansah, Stephen Amisah, Daniel Adjei-Boateng, Nelson W. Agbo, and Hillary Egna.

The trajectory of aquaculture growth in sub-Saharan Africa has necessitated closer attention to the use of environmental best management practices (BMPs). Two BMPs in particular, water reuse and floating feeds, are being promoted for adoption by pond fish farmers in sub-Saharan Africa. In this study, we investigated: (1) the effect of water source and feed type on water quality; (2) the effect of water source and feed type on tilapia growth; and (3) the quality of potential effluents from ponds using different water source and feed types. The study was conducted in Ghana using on-farm experiments involving monitoring of water quality and growth of Nile tilapia *Oreochromis niloticus* for 160 days. Although considered low-intensity production systems, nutrients and solids in the study ponds exceeded levels expected in intensive culture ponds by wide margins, whereas BOD₅ was within the range for semi-intensive ponds. Floating feed was associated with higher water quality, especially dissolved oxygen, and higher growth, but water source did not significantly affect growth. Water reuse appears to be a viable BMP for sustainable aquaculture in the region, but the use of floating feed as BMP will depend on the economic profitability of floating feed use.

This abstract was excerpted from the original paper, which was published in Sustainability (2014), 6: 652-675.

Role for leptin in promoting glucose mobilization during acute hyperosmotic stress in teleost fishes (14-333).

David A. Baltzegar, Benjamin J Reading, Jonathon D. Douros, and Russell J. Borski.

Osmoregulation is critical for survival in all vertebrates, yet the endocrine regulation of this metabolically expensive process is not fully understood. Specifically, the function of leptin in the regulation of energy expenditure in fishes, and among ectotherms, in general, remains unresolved. In this study, we examined the effects of acute salinity transfer (72 h) and the effects of leptin and cortisol on plasma metabolites and hepatic energy reserves in the euryhaline fish, the tilapia (*Oreochromis mossambicus*). Transfer to 2/3 seawater (23 ppt) significantly increased plasma glucose, amino acid, and lactate levels relative to those in the control fish. Plasma glucose levels were positively correlated with amino acid levels (R²0.614), but not with lactate levels. The mRNA expression of liver leptin A (*lepa*), leptin receptor (*lepr*), and hormone-sensitive and lipoprotein lipases (*hsl* and *lpl*) as well as triglyceride content increased during salinity transfer, but plasma free fatty acid and triglyceride levels remained unchanged. Both leptin and cortisol significantly increased plasma glucose levels *in vivo*, but only leptin decreased liver glycogen levels. Leptin decreased the expression of liver *hsl* and *lpl* mRNAs, whereas cortisol significantly increased the expression of these lipases. These findings suggest that hepatic glucose mobilization into the blood following an acute salinity challenge involves both glycogenolysis, induced by leptin, and subsequent gluconeogenesis of free amino acids. This is the first study to report that teleost leptin A has actions that are functionally distinct from those described in mammals acting as a potent hyperglycemic factor during osmotic stress, possibly in synergism with cortisol. These results suggest that the function of leptin may have diverged during the evolution of vertebrates, possibly reflecting differences in metabolic regulation between poikilotherms and homeotherms.

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This abstract was excerpted from the original paper, which was published in *The Journal of Endocrinology* (2014), 220(1): 61-72.

Effects of addition of maize starch on the yield, water quality and formation of bioflocs in an integrated shrimp culture system (14-334).

Liping Liu, Zhenxiong Hu, Xilin Dai, and Yoram Avnimelech.

Integrated Multi-Trophic Aquaculture (IMTA) is an ecological and economic farming strategy that minimizes waste from culture systems, reduces the risk of diseases and provides additional income source. A trial was conducted to evaluate the effects of adding maize starch on the yield, water quality, formation of bioflocs and economic return in an IMTA system comprising white shrimp (*Litopenaeus vannamei*), spotted scat (*Scatophagus argus*) and water spinach (*Ipomoea aquatic*). Shrimp were randomly assigned to 12 cemented tanks (T1, T2, T3 and T4 with three replicates) and reared in monoculture (T1) without the addition of starch, or in polyculture (with spotted scat and water spinach) with (T3 and T4) or without (T2) the addition of starch. Shrimp in T4 were fed at 80% of the feeding amount of other treatments. The results showed that shrimp survival was higher in T3 and T4 (95.6% and 94.3%, respectively) than in T1 and T2 (51.1% and 56.5%, respectively) ($P < 0.01$). The shrimp yield was the highest in T3 (0.495 kgm⁻³), which also had the lowest feed conversion ratio (1.02) and best economic performance. The levels of nitrite-N (NO₂-N) were significantly lower in T3 and T4 at the end of the experiment than in other treatments ($P < 0.01$). Similarly, total ammonia nitrogen (TAN) was lower and total suspended solids (TSS) was higher in T3 and T4 than in T1 and T2 ($P < 0.05$). The results suggested that the addition of starch into the IMTA system of shrimp, spotted scat and water spinach improved productivity, profitability and water quality. The combination of the IMTA model and biofloc technology had a synergistic effect on overall FCR and economic return, and was more effective at improving shrimp survival, production and

reducing nitrite-N and TAN than use of the IMTA model alone.

This abstract was excerpted from the original paper, which was published in *Aquaculture* (2014), 418-419: 79-86.

Price integration in the farmed and wild fish markets in Uganda (14-335).

James O. Bukenya and Maurice SSebisubi.

This paper looks at price integration in the aquaculture and wild-harvested African catfish market channels in Uganda. The issue of integration between the two market channels is important because African catfish has become an important traded species in Uganda with exports to regional markets rising even faster than production, yet limited research has been undertaken to understand price formation in the supply chain. The analysis draws on monthly price data from January 2006 to August 2013, and applies threshold autoregressive approaches to test for the existence of a long-run relationship and price asymmetry and to determine the time path needed for shocks to be transmitted from one market channel to the other. The results show that, over the studied period prices in both market channels are linked in the long-run, implying that farm-raised catfish forms part of the same market as wild-harvested catfish in the country. The findings have strong implications for aquaculture producers and artisanal fishers as they can serve as a basis for more efficient farm management and marketing decisions.

This abstract was excerpted from the original paper, which was published in *Fisheries Science* (2014), 80(5).

Effects of Reduced Soybean-Meal Diets Containing *Moringa oleifera* or *Leucaena leucocephala* Leaf Meals on Growth Performance, Plasma Lysozyme, and Total Intestinal Proteolytic Enzyme Activity of Juvenile Nile tilapia, *Oreochromis niloticus*, in Outdoor Tanks (14-336).

Tom Kasiga, Ruguang Chen, Todd Sink, and Rebecca Lochmann.

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Leaf meals are potential alternatives to soybean meal (SBM) in fish diets in developing countries because they are cheaper. *Moringa oleifera* (MOR) and *Leucaena leucocephala* (LEU) reduced nutrient digestibility of diets compared with SBM in an earlier study. However, fish raised outdoors consume natural foods, which might offset the negative effects of leaf-meal diets. We conducted a feeding trial using mixed-sex Nile tilapia (5.2 g) to assess performance of fish fed 36% protein diets with different concentrations of MOR and LEU leaf meals in place of SBM. Fish in static pools were fed daily to apparent satiation for 59 d. Individual weight gain (30.4–34.7 g), survival (91.8–97.3%), feed conversion ratio (FCR, 1.6–1.9), proximate composition, plasma lysozyme activity, and intestinal proteolytic enzyme activity were similar among diets. However, fish fed diets containing leaf meals had higher concentrations of n-3 fatty acids than those fed the SBM control. Despite lower nutrient availability of the leaf-meal diets compared with the soy diet, MOR or LEU could replace up to 30% of the SBM protein without reducing fish performance. Inclusion of poultry meal in the diets and probable nutrient supplementation from natural foods appeared to compensate for the lower nutritional value of the leaf meals compared with SBM.

This abstract was excerpted from the original paper, which was published in *Fisheries Science* (2014), 45(5): 508-522.



Tenure and Fishing Rights 2015 (UserRights 2015)

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Siem Reap, Cambodia

<http://www.fao.org/cofi/33211-0140545c1e76fe6ccdb7324909e2388d4.pdf>

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5-6 April 2015

Dubai, UAE

www.marevent.com/MEAF2015_DUBAI.html

2nd International Symposium on Aquaculture and Fisheries Education (ISAFE2)

22-24 April 2015

Shanghai, China

www.aarm-asialink.info/isafe-committee.html

World Aquaculture 2015

26-30 May 2015

Jeju Island, South Korea

www.was.org/eventCalendar.aspx

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24-26 June 2015

Amsterdam, The Netherlands

www.openchannels.org/conferences/mare-academic-conference-2015-people-and-sea-viii

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World Aquaculture Society

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