



THIS ISSUE DEDICATED TO THE MEMORY OF DR. YANG YI

19 JUNE 1963- 31 JULY 2009

A TRIBUTE FROM JIM DIANA



It is sad to note the death of our dear friend and colleague, Dr. Yang Yi. He passed away at 2:41 a.m. on 31 July 2009 at Chengdu Huaxi Hospital, at the age of 46.

Yang Yi was an accomplished scholar, an excellent researcher, and an innovator in the field of aquaculture, especially in applying simple techniques to gain efficiency for small-scale farmers with limited incomes.

Yang Yi was born on 19 June 1963 in Chengdu, China, eldest of three boys born to Yang Chu and Peng Xuejing. He was raised in several locations throughout Sichuan Province and spent much of his formative years living with his grandparents, Yang Zhengqing and Hu Bingxian. His son, Yang Tongyun (Tony) is ten years old. His wife, Liu Yun, and son currently live in Chengdu and Shanghai.

Yang Yi was a bright young man and also a good athlete. At an early age, he was placed in a program to advance his volleyball skills. Later, he decided to focus more on academics. He received his BSc in Genetics from Sichuan University, China in 1985, and his MSc and Doctor of Technical Science degrees in Aquaculture from the Asian Institute of Technology, Thailand in 1992 and 1997, respectively.

One of the more interesting and engaging parts of collaborative research funded through USAID has been the opportunity for participants to work with and get to know collaborators from various countries. The relatively long time period during which we have been studying in certain regions has allowed many CRSP researchers to develop close friendships and very strong academic ties. This certainly has been the case for me, Kwei Lin, and Yang Yi. Yang Yi was a true product of the CRSP: his doctoral work was funded by CRSP projects, he served for years as a research investigator with the CRSP, and his most recent position was as host country principal investigator for the CRSP.

I first became associated with Yang Yi in the early 1990s, when he was a graduate student at the Asian Institute of Technology. He had moved to Thailand from his home country, China, to attend graduate school, and was working on a master's degree. AIT funding provided him an opportunity to conduct his graduate work on sex reversal of tilapia. He completed his master's degree in 1992 under the supervision of David Little.

In 1992, Yang Yi began a doctor of technical science

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program at AIT under supervision of Kwei Lin, and also became funded as the research associate for the CRSP project. At the time, Kwei was the host country PI at AIT. Kwei and I had been working for some time on projects combining cage and pond culture, with cage culture of pellet-feeding fish in the middle of a pond and open water culture of tilapia, based on the waste products from the cage-culture system. Kwei had developed a system for walking catfish in the cage and tilapia in the pond, and expanded it to local aquaculture extension organizations. This combination really piqued Yang Yi's interest and became the focus of much of his research career.

Yang Yi's dissertation work focused on co-culture of tilapia in cages and ponds. His basic premise was that one could grow large tilapia in cages using pellets, grow small tilapia in the open water using waste products to stimulate phytoplankton and zooplankton for tilapia consumption, and balance the two systems so the young fish from the ponds could be stocked in the cages for the grow-out to a large size. The system developed by Yang Yi is highly productive and integrated (see [Sidebar on page 15](#)), using feed for all nutrient inputs and capturing as much of the nutrients in tilapia as possible.

My first prolonged exposure to Yang Yi was when he came to the University of Michigan in 1996-97 to complete a year of study abroad in our graduate program. He decided to focus on two main goals while at our university: learning to write and speak English more effectively, and learning more about statistics, experimental design, and modeling. He took coursework to help with these goals and also worked on writing his dissertation and publications from his dissertation while at UM. I had the pleasure of working regularly with Yang Yi during this time, helping him develop his writing skills. I did not realize then what a great investment this would be, because Yang Yi would then spend the next 12 years researching and writing excellent scholarly papers. He was an avid writer and published prolifically, mainly on results of the CRSP experiments. The limited time I dedicated to his program in 1996 has been reciprocated dramatically many times over.

Upon the completion of his doctorate, Yang

Yi became a seconded faculty member at AIT, funded as a post-doctoral researcher by University of Michigan and the Aquaculture CRSP. He eventually became the host country PI when Kwei Lin retired from AIT in 2002, and advanced through the academic system at AIT, becoming assistant professor in 1999, associate professor in 2003, and chair of the Department of Aquaculture and Aquatic Resources Management in 2005. Yang Yi became a key faculty member at AIT, helping a very productive aquaculture training program produce a large and significant cohort of students who have established aquaculture programs throughout Asia. During his time at AIT he advised 4 PhD and 14 MSc students. Thanks in part to the involvement of devoted faculty like Yang Yi, the program at AIT at the time was one of the strongest aquaculture programs in the world, and certainly the strongest in training Asian students.



Even with his long-term involvement in Thailand at AIT, Yang Yi had always desired to return to his native China. In August 2007, he was hired as a professor at Shanghai Ocean University, as well as director of the Sichuan Aquacultural Engineering and Technology Research Center in Chengdu. The research center is a part of Tongwei Group, the major feed producer for China, as well as an important aquaculture production and green technology company. Although his tenure at Shanghai Ocean University was short, he had already begun advising 2 PhD and 6 MS students.

Yang Yi was a great friend to many of us on the CRSP over the years. For example, when the World Aquaculture Society met in Beijing in 2002, Yang Yi organized several adventures for those of us visiting from out of country. I remember a trip to the Peking Opera, and another to eat Peking duck.

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The trip to the opera involved over 50 people, who traveled on a bus to the venue. He was thrilled to show others his native country and his culture. He repeated this several times for me, making travel arrangements, introducing me to his parents and other family, and treating me like family. I



have always been impressed with his willingness to work so hard to make people happy.

Yang Yi earned a number of honors during his academic career. He was the president of the Asian Fisheries Society since 2007. He consulted internationally in Egypt, Mali, Indonesia, and many other countries. He published broadly in the major journals in our field and took his research through the full circle of development, data collection, modeling, implementation, and publication.

Yang Yi was a great example of all the things collaborative research can do. It allowed him to develop his graduate program, which led him to an academic career focused on aquaculture, and eventually to becoming an expert in the field and president of a major society. Members of the CRSP should take great pride in his achievements, as he gave back even more to the field of aquaculture than he received from CRSP funding. Aquaculture has grown dramatically since the CRSP was initiated in 1982, and in large part, this growth has been due to the development of remarkable scientists like Yang Yi.

While I know it will happen, I cannot really imagine working on the CRSP projects without Yang Yi's presence. He was a great friend, colleague, and an inspiration to me. He will always be remembered by his aquaculture family, and he will be missed. God bless him and his family as we learn to go on without him.

YANG YI OBITUARY

EXCERPTED FROM THE ASIAN FISHERIES SOCIETY NEWSLETTER

It is with great sadness that I wish to announce the passing away of Professor Yang Yi, the beloved President of the 9th Council of the Asian Fisheries Society (AFS) on 31 July 2009. The Society had lost a great friend and a leader in aquaculture.

On behalf of the Council and members of the Asian Fisheries Society, I wish to extend my heartfelt condolence and sympathy to his family and parents in Chengdu. Professor Zhou Yingqi and I attended Yang Yi's burial on Sunday 2 August 2009 in Chengdu on behalf of the Society.

Yang Yi was born on the 19 June 1963. He received his BSc from Sichuan University, China in 1985 and his MSc and Doctor of Technical Science degrees from the Asian Institute of Technology (AIT), Thailand in 1992 and 1997, respectively. His research focused on aquaculture production systems, aquaculture wastewater treatment and recycling, water quality analyses and management in aquaculture, fish genetics, and information data.

Yang Yi was a visiting research investigator at the University of Michigan, USA, where he gained advanced knowledge in computer modeling, experimental design, and data analyses. He had more than 20 years of teaching and research experience in aquaculture. He was an Associate Professor at AIT seconded by the University of Michigan through its USAID sponsored Aquaculture CRSP project from June 1999 to July 2007.

In 2007 he re-located back to China and took up the position of Professor at the Shanghai Ocean University, a board member of the Tongwei Company Ltd, and the Director of Sichuan Aquacultural Engineering and Technology Research Center in Chengdu, China. He has coordinated the Aquaculture CRSP activities in South and Southeast Asian countries namely

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To view the webpage from Yang Yi's memorial service on the Shanghai Ocean University homepage (in Chinese) please go to http://www.shou.edu.cn/news/news_detail.asp?ID=11152

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Bangladesh, Nepal, Vietnam, and China since 1999.

Yang Yi was a very active member of The Asian Fisheries Society. His contributions were recognized by AFS members and he was elected as the President of the 9th AFS council for 2007-2010.

Yang Yi was an excellent aquatic scientist and a friend to many young scientists in Asia. He had always worked tirelessly for AFS and my great personal friend. His departure will be sorely missed by me and all his friends and colleagues in the Asia-Pacific.

Our friend Yang Yi—Rest In Peace.

Chan-Lui Lee PhD
Immediate Past President, AFS
21 August 2009

A TRIBUTE TO YANG YI FROM AQUAFISH CRSP DIRECTOR, HILLARY EGNA

With this special issue of Aquanews, we are honoring the memory of our dear friend and esteemed colleague, Dr. Yang Yi, who passed away on 31 July, 2009. Like many of you, I feel his loss profoundly. Too many times have I gone to write him an email, or call, and then realize his absence. Yang Yi and I were in weekly contact over a myriad of things during the past 18 years. I see his footprint on almost everything we do in CRSP. He was interested in training West Africans in the US with joint Chinese government funding. He wrote to me about networking opportunities for the Asian Fisheries Society, where he was serving as president at his time of death. He leveraged his work in R&D for the Tongwei research center in Chengdu to end poverty. He was proud of China and wanted to show me China's most beautiful places.

My most recent trip to China this August was distressing, it was a week after Yang Yi had passed away. Yang Yi left an itinerary and wishes for me to fulfill — to build bridges with his colleagues, and to strengthen CRSPs' ability to continue working in China and the SE Asia region that Yang Yi so adeptly covered for CRSP. I feel fortunate



and honored to have been hosted by the many people who respected Yang Yi at Shanghai Ocean University and in the Tongwei Group. Even so, everyday was a challenge, especially when I was in Yang Yi's home where his wife and son were still living. Yang Yi's books and professional papers were stacked in neat, high piles, topped with his memorable black square-pointy shoes. His offices at Tongwei and at SOU were already growing bare, which felt terribly sad. His protégé, Liu Liping, his friend, Jiang Min, his family, SOU President Yingjie Pan, and colleagues at Tongwei and SOU offered new perspectives on the life of a dear friend, shared their photos of Yang Yi with me, and were a warm reminder of the sense of being among a large great family all connected through Yang Yi. I left after 5 filled days, and felt better knowing that Yang Yi's family, students, and research were in good hands with the many wonderful caring people in Yang Yi's life.

Yang Yi possessed a rare knowledge of aquaculture— a knowledge that cut across disciplinary boundaries, from theory into practice. In my many years in aquaculture and fisheries, I haven't come across many like him, with his depth and breadth of knowledge, his ability to explain complexity, reach out to producers, and mentor students with compassion and purpose. The immensity of his loss—right when he was poised to make even more outstanding contributions—is matched by his profound influence on this next generation of aquaculturists. Yang Yi will be missed for many, many years to come.



THE AQUAFISH CRSP SUPPORTS A NEW PROJECT WITH AUBURN UNIVERSITY

The AquaFish CRSP Management Entity has selected a new research project entitled "Hydrology, Water Harvesting, and Watershed Management for Food Security, Income and Health: Small Impoundments for Aquaculture and other Community Uses" that was submitted in February 2009 in response to the IEHA* RFP. Joseph Molnar of Auburn University will serve as the Lead Principal Investigator. The project's five investigations address a broad range of water management, production, credit, and extension issues in South Africa and Uganda.

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ONLINE TRIBUTE TO YANG YI

AquaFish CRSP has planned a tribute to Yang Yi on our website, and we will be working with several professional societies and universities on memorials. For this coming WAS 2010 in San Diego, I organized and am chairing a special session "Optimizing Small-Scale Aquaculture for the Poor: A Session in Honor of Dr. Yang Yi." Jim Diana, Kwei Lin, Yuan Derun, Liu Liping and many others will come together to talk about the kind of aquaculture discoveries that mattered so much to Yang Yi. I am working on dedicating an annual award at WAS to an accomplished scientist in Yang Yi's memory. With Jim Diana and others, best paper awards will be given to students at WAS whose work features elements of Yang Yi's vision. At SOU, President Yingjie Pan and Liu Liping have arranged for a special collection space in their University library in honor of Yang Yi and aquaculture. CRSP is sending books and journals through its library donation project to this collection. Other plans at SOU, AFS, AIT, ISTA and elsewhere include setting up a foundation to support students in degree programs, offer travel awards for students and young professionals—in Yang Yi's honor. These tributes underscore how privileged we have been to have worked alongside Yang Yi.

-Hillary Egna

For the tribute to Yang Yi on our website, please consider writing a short memory of Yang Yi or sending a photo of Yang Yi to aquafish@oregonstate.edu

Goings-on in the Pond...



In honor of our friend and colleague, Yang Yi, the AquaFish CRSP session at the WAS Aquaculture 2010 conference in San Diego, CA, will be held in his name. The half-day session entitled, "Optimizing Small-Scale Aquaculture for the Poor: a WAS Session in Honor of Dr. Yang Yi" will begin with a Yang Yi memorial lecture given by Dr. Kwei Lin.

The Sustainable Aquaculture Research Networks in Sub-Saharan Africa (SARNISSA) website is now linked with the AquaFish CRSP website. SARNISSA has also made many of the AquaFish CRSP publications available in the CABI Aquaculture Compendium, reaching out to over 1,000 SARNISSA registered stakeholders. For more information on the compendium see: www.cabicompendium.org/ac

In the July 2009 issue of PRODUCTORES DE HORTALIZAS, AquaFish CRSP Lead PI, Kevin Fitzsimmons is featured in the article entitled, "Como Peces en el Agua." Written by Sussane Stover, the article discusses the symbiotic system of aquaponics.

The article (in Spanish) is online at: hortalizas.com/pdh/?storyid=1819

The World Aquaculture Conference, 25-29 September 2009 in Veracruz, Mexico, featured several AquaFish researchers and associates. See: www.was.org/WasMeetings/meetings/Default.aspx?code=WA2009

Odipo Osano, former Aquaculture CRSP host country co-PI, was recently appointed Dean of the School of Environmental Studies at Moi University in Kenya. Odipo's previous work with ACRSP focused on watershed assessment and management through the Kenya Project.

The International Symposium on Aquaculture & Fisheries Education was held 27-30 November 2009 at Asian Institute of Technology in Bangkok, Thailand. www.aarm-asialink.info/isafe-2009.pdf

UNIVERSITY OF ARIZONA RESEARCH TEAM WINS EPA P3 AWARD

In April 2009, a team of interdisciplinary student researchers at the University of Arizona received the U.S. Environmental Protection Agency's People, Prosperity and Planet (EPA P3) award for their project "Development of Sustainable Integrated Aquaculture Systems with Assessment of Environmental, Social, and Economic Implications." Supported by AquaFish CRSP Lead US Principal Investigator Kevin Fitzsimmons, the team of three UA graduate students includes Mauricio Torres-Benavides, and AquaFish CRSP funded students Rafael Martinez-Garcia and Kyle VanderLugt.

The EPA P3 competition involves two phases that culminate with a final judging at the Annual National Sustainability Design Expo in Washington DC. With a focus on benefitting people, promoting prosperity, and protecting the planet, the competition encourages participants to apply technology in innovative ways to address environmental sustainability issues in both the developed and the developing world. This year \$75,000 was awarded to each of the six teams with the best designs to help them to implement their projects in the field and in the marketplace.

The winning UA design is a hybrid hydroponics system, which the team named "re-circulating integrated agriculture aquaculture" (RIAA). With a 97% water conservation rate, RIAA combines aquaculture with agriculture, using the nutrient rich aquaculture effluents from fishponds to fertilize and grow crops. As the nutrient rich effluent water irrigates the crops, nitrogen and phosphorous are taken up by the plants and the nutrient-depleted water is collected from the runoff and re-circulated back into the fishponds.

With the success of their award winning system, the UA team has the opportunity to further develop their design and take it into the marketplace. Through ties with AquaFish CRSP, the team has made contact with researchers at the University of Tabasco (UJAT) in Mexico and will be taking the RIAA system to the rural community of Tacotalpa. The project is in the preliminary steps of its implementation stage. This summer the team visited their sites in Mexico to further



*The University of Arizona research team receives their EPA P3 award in Washington DC, April 2009. Pictured from left to right, Mauricio Torres-Benavides, Kyle VanderLugt, Rafael Martinez-Garcia and UA professor Kevin Fitzsimmons.
(Courtesy of Rafael Martinez-Garcia)*

assess feasibility. They also met with researchers from UJAT at the World Aquaculture Society Conference in Veracruz, Mexico. The team hopes that their design will provide the community with a sustainable agro-aqua system, which will avoid the need for inorganic fertilizers in their crops and supply a treatment mechanism for their aquaculture effluents. Furthermore, the new technologies can help to create new jobs and further develop the local economy.



UNIVERSITY OF ARIZONA IN MEXICO: THE TIES PARTNERSHIP

The University of Arizona and the former Aquaculture CRSP Mexico project leveraged funding to win the US-Mexico University Training, Internships, Exchange and Scholarships (TIES) Partnership in 2005. The TIES partnership is a three-year program intended to strengthen higher education capacities through the exchange of scientists and scholars between US and Mexican universities. Ending in 2008, the TIES partnership with UA was very successful and has led to the creation of an undergraduate student interchange program between UA and its Mexican partners to foster the collaborative partnership.

For more information on the 2009 TIES Partnership see our recent posting in EdOP Net at:
aquafishcrsp.oregonstate.edu/edop.php

GRADUATE STUDENT PROFILE: MARGARETH M. KIBODYA



Margareth M. Kibodya is a graduate student from Tanzania, studying at the Sokoine University of Agriculture (SUA). She is currently working under AquaFish CRSP host country principal investigator Sebastian Chenyambuga to assess the potential uses of

two local plants as a protein source in aquaculture feed. Her thesis work, *Assesment of Moringa oleifera and Leucaena leucocephala as Protein Supplements in Tilapia (Oreochromis niloticus) Diets*, will contribute directly to the AquaFish CRSP project with Purdue University, "Improving Competitiveness of African Aquaculture through Capacity Building, Improved Technology, and Management of Supply Chain and Natural Resources." The two plants, *M. oleifera* and *L. leucocephala*, could make aquaculture feed more readily available and allow for improved profits for small-scale farmers. Margareth's work will not only help to provide a more reliable source of feed, it could also help foster the growth of aquaculture in Tanzania.

Originally from the town of Iringa in the central part of Tanzania, Margareth graduated from Open University of Tanzania in 2006 with her bachelor's degree in Zoology. Due to her interest in fisheries and natural resources, Margareth started her work at SUA hoping to enhance the capacity of fish



Margareth Kibodya collecting data, detemining fat content of tilapia feed containing proteins from local plants in Tanzania. (Courtesy of Kwamena Quagrainie)

farming in her home country. Margareth's research has recently been completed, finding that *M. oleifera* and *L. leucocephala* can supplement soybean meal in fish diets at levels up to 25%. She is now in the process of finalizing her work.

With aquaculture growth in Tanzania limited in part by the availability of reliable feed sources, Margareth's research is helping to bring a broader awareness to the aquaculture community. In response, Margareth has noticed that aquaculture activities are being more widely embraced and new fishponds are emerging. Margareth hopes that her research will continue the expansion of aquaculture throughout Tanzania enhancing local economies through the use of their available resources.



For more information on the AquaFish CRSP research on alternative feeds in Tanzania and Margareth's contributions please see page 12.

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Under the project theme, "Income Generation for Small- Scale Fish Farmers," the five investigations focus on:

- **EFFECTS OF WATERSHED AND AQUACULTURE ON WATER QUANTITY AND QUALITY IN SMALL CATCHMENTS IN SOUTH AFRICA AND UGANDA**
US PI: Claude Boyd, Auburn University
HC PIs: Khalid Salie, Stellenbosch University, South Africa and Levi Kasisira, Makerere University, Uganda
- **EVALUATION OF SURFACE CATCHMENT DEVELOPMENT AND SUSTAINABILITY FOR MULTIPURPOSE WATER NEEDS IN UGANDA**
US PIs: William Tolner, University of Georgia; Claude Boyd & Joseph Molnar, Auburn University; James Bukenya, Alabama A&M University
HC PI: Levi Kasisira, Makerere University, Uganda
- **EVALUATION AND IMPROVEMENT OF PRODUCTION TECHNOLOGY IN UGANDA: CASE STUDIES OF SMALL-HOLDER CAGE CULTURE IN WATERSHED RESERVOIRS**
US PI: Joseph Molnar, Auburn University
HC PI: Gertrude Atakunda, National Fisheries Resources Research Institute, Uganda
- **MARKET ASSESSMENT AND PROFITABILITY ANALYSIS OF AQUACULTURE ENTERPRISES IN UGANDA**
US PI: James Bukenya, Alabama A&M University
HC PI: Theodore Hyuha, Makerere University, Uganda
- **TRAINING AND OUTREACH IN UGANDA AND SURROUNDING NATIONS**
US PI: Joseph Molnar, Auburn University
HC PI: Nelly Isyagi, Gulu University, Uganda

*IEHA: Presidential Initiative to End Hunger in Africa.

ALTERNATIVE FEEDS FOR AQUACULTURE IN VIETNAM AND CAMBODIA

David A. Bengtson, Tran Thi Thanh Hien, Chong M. Lee, and Robert S. Pomeroy

Aquaculture is growing rapidly in Vietnam and has the potential to do the same in Cambodia. Production of pangasiid catfish in the Mekong Delta of Vietnam alone exceeded 1 million metric tons in 2008. While some of the food provided to these fish, especially at the larger commercial farms, is pelleted feed from commercial feed mills, many small farmers still use “trash fish” from the Mekong in preparing feed by hand at the farm. In Cambodia, catfish culture is still at the small-farm stage and trash fish comprise the basic feed for the industry (which is considerably smaller in Cambodia than in Vietnam).

It may be more appropriate to refer to the fish used as feed in Cambodian and Vietnamese aquaculture as “small fish” rather than “trash fish.” Trash fish implies fish with no direct value as human food. Unfortunately, that is not always the case for small fish taken from the Mekong River, as well as the Tonle Sap great lake in Cambodia. At least some of those small fish collected are juvenile stages of species that could grow up to be valuable human food. In addition, small fish have traditionally been taken by Cambodian fisheries for use in production of fish sauce, a fermented product that is popularly used in Cambodian cooking and can represent an important source of protein in the diets of some Cambodians. Finally, small fish are likely eaten directly by the poorest of the poor living along the river.

As aquaculture expands in Vietnam and Cambodia, the fish called snakehead is becoming popular to culture because of its high value in the market. There are two species currently being cultured, *Channa striata*, the snakehead murrel, and *Channa micropeltes*, the giant snakehead. While culture of these is permitted (and growing) in Vietnam, it is prohibited in Cambodia (except for some experimental work) due to dependence on small fish in their diet. While pelleted diets do not exist for snakehead in Vietnam and Cambodia, catfish culture does have commercial pellet diets available. Thus getting farmers to switch from small fish to

pellets is a socioeconomic issue.

We are participating in the AquaFish CRSP project entitled “Development of Alternatives to the Use of Freshwater Low Value Fish for Aquaculture in the Lower Mekong Basin of Cambodia and Vietnam: Implications for Livelihoods, Production and Markets”. The project falls under the AquaFish project theme of “Enhanced Trade Opportunities for Global Fishery Markets” and consists of five investigations:

- Competition and Impacts between Use of Low Value/Trash Fish for Aquaculture Feed versus Use for Human Food
- Assessment of Diversity and Bioecological Characteristics of Low Value/Trash Fish Species
- Alternative Feeds for Freshwater Aquaculture Species
- Feed Technology Adoption and Policy Development for Fisheries Management
- Maximizing the Utilization of Low Value or Small Fish for Human Consumption through Appropriate Value Added Product Development

In particular, we are reporting on the third investigation, “Alternative Feeds.”

Pelleted diets for freshwater fish must provide complete nutrition for a particular species in terms of the required amounts of protein, lipid, energy, vitamins and minerals. Piscivorous (fish-eating) fish like snakehead typically require high levels of protein in the diet, reflecting the high protein in their natural diet. The usual source of that protein in pellet diets is fishmeal, an international commodity made from species such as anchovy, herring, menhaden, capelin, etc. Fish nutritionists and aquaculturists worldwide are trying to replace fishmeal with plant proteins because of the high price of fishmeal, and to reduce the fishing pressure on the aforementioned species. At the University of Rhode Island (URI), we have been able to replace up to 40% of the fishmeal in diets for summer flounder *Paralichthys dentatus* with soybean meal, as long as certain essential amino acids and the non-essential amino acid taurine are included in the diet. Plant materials can sometimes include phytin, which interferes with mineral nutrition, so diets with protein sources such as soybean meal

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RECENT TRAININGS IN MALI

Lisa Reifke

The AquaFish CRSP Mali Project, "Aquatic Resource Use and Conservation for Sustainable Freshwater Aquaculture and Fisheries in Mali," successfully completed several key activities in recent months. These activities fall within the three themes of the project: Pond Culture, Rice-fish Culture, and Fisheries Planning.

Pond Culture: Theme I leader Charles Ngugi, with support from Héry Coulibaly, Mali Director of Fisheries and his technical staff, led two training courses for. The first of these was held in April, during which four Malians, Boureima Traore, Rokia Coulibaly, Mamadou Kane, and Seydou Toe travelled to Kenya to receive a series of short-term trainings. The trainings covered pond culture, including catfish propagation, tilapia sex reversal techniques, pond record keeping, and business plan development for aquaculture. Held at the Sagana Aquaculture Centre, the training consisted of practicals, lecture sessions, and a field trip. The second workshop, a two-week training course on hatchery management and propagation of catfish, took place in Bamako during late June. A total of 22 participants, including fish farmers, Regional Fisheries Directors, technicians, and farmers, were trained through a combination of practicals and lecture sessions. Former CRSP graduate student James Mugo (Moi University) assisted Ngugi in these training courses. Following the conclusion of the short course in Bamako, Ngugi and Mugo



Malian technicians and farmers working alongside trainers and station workers during the Theme I ("Pond Culture") short course held at Sagana Aquaculture Centre, Sagana, Kenya, in April 2009. (Courtesy of Héry Coulibaly)

worked with the four Malians trained in Kenya to set up and initiate a key Theme I activity, on-farm trials of alternative pond culture technologies, which will continue through mid January 2010.

Rice-Fish Culture: Building on experience gained during their short course in China last year, Alhassane Toure and Tieman Traore formed a farmers' group in the Baguineda irrigation area and held a workshop in which they presented techniques on rice-fish culture to potential participants. Liu Liping of Shanghai Ocean University and Wu Zongwen from the Tongwei Research Center in Chengdu went to Mali in June to make final arrangements for the demonstrations. Four farmers' rice fields were modified (excavation of fish sumps) for use as demonstration sites. These fields were stocked with catfish, tilapia, or a combination of tilapia and catfish. The rice-fish demonstrations ran through November 2009.



A rice field in the Baguineda irrigation area that has been adapted for rice-fish culture. Excavated side channels lead to a fish sump in one corner.

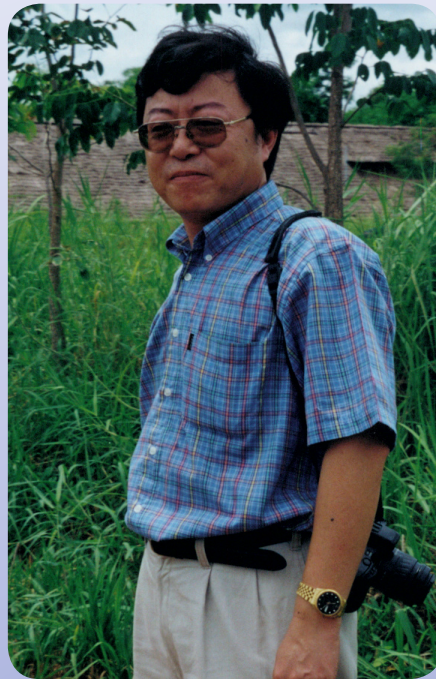
(Courtesy of the Direction Régionale de la Pêche-Koulikoro)

Fisheries Planning: Analysis of the data obtained during the Lake Sélingué frame survey conducted in February was completed and a full report was provided to the Direction Nationale de la Pêche (Héry Coulibaly) by Theme III leader Nancy Gitonga. Dr. Coulibaly's team had the report translated into French to ensure its usefulness to fisheries planners in Mali. The information gained through this survey will be used during upcoming stakeholders' workshops as a basis for understanding the present status of the lake fishery and for working out future management plans.



YANG YI

19 JUNE 1963- 31 JULY 2009





LOCAL PLANTS SHOW PROMISE OF NUTRITIONAL VALUE FOR TILAPIA GROWTH IN TANZANIA

Submitted by Kwamena Quagrainie

In and around villages and towns in Tanzania, cattle, sheep and goats roam freely, grazing on various forages, such as *Leucaena leucocephala* and *Moringa oleifera*. These forage plants are excellent sources of digestible protein and could hold promise in addressing some of the protein needs in fish feed in Tanzania.

Tanzania is among sub-Saharan African countries where the government has embraced fish farming as a potential agricultural enterprise that could provide needed protein sources to its citizens. However, potential growth in the industry is limited by the availability of seed and feed.

Kajitanus Osewe, the Tanzania Deputy Director of Fisheries & Aquaculture, acknowledges that the lack of nutritious feed is a major hindrance to the development of the Tanzanian aquaculture industry. "There is no formulated feed available to fish farmers, and the few available ones are expensive," he said "Small-scale fish farmers rely solely on household food wastes, agricultural byproducts and wastes as major feed inputs in fish farming." The Aquaculture & Fisheries Collaborative Research Support Program (AquaFish CRSP) has therefore undertaken a study to examine the performance of two local plants as protein sources in feed, *L. leucocephala* and *M. oleifera*.

In his 1983 *Handbook of Energy Crops*, James Duke reports that the nutritional value of *L. leucocephala* is comparable to or even higher than that of alfalfa, and makes a better animal feed ingredient for sources of several amino acids than does copra. Duke reports that the leaves of *L. leucocephala* contain 2.9 grams protein per 100 grams edible portion while the leaves of *M. oleifera* contain 6.7 grams protein.

The study examined nine diet formulations all of which contained 40 percent protein source (soybean or *M. oleifera* or *L. leucocephala* leaf meal or mixtures of soybean and the leaf meals), 58% energy source (maize bran), and 2% mineral mix.



Researchers are experimenting with the leaves from local trees, *M. oleifera* (left) and *L. leucocephala* (right), as ingredients in tilapia feed. (Courtesy of Kwamena Quagrainie)

The fish were fed twice per day on the respective diets at a rate of 10 percent of body weight. The results indicate that dietary formulations consisting solely of *L. leucocephala* leaf meal and *M. oleifera* leaf meal as protein sources resulted in slower growth rate and smaller body size at 90 days than those fed solely on soybean meal as protein source. However, fish fed on a diet in which soybean meal was supplemented with *M. oleifera* leaf meal at 25 percent level had comparable growth rate and body size as those fed on a diet in which soybean meal was the sole source of protein. Diets in which 25 percent of soybean meal was replaced with *L. leucocephala* leaf meal, also showed growth rate and body size comparable to diets with soybean meal as the sole source of protein.

The study was conducted at Sokoine University of Agriculture in Tanzania. According to CRSP host country investigator, Sebastian Chenyambuga, the nutritional quality of leguminous multipurpose trees in Tanzania are usually maintained for most of the year, even in the dry season, because of prolonged production of green forage. "*Leucaena leucocephala* and *Moringa oleifera* are deep rooted and can access soil water and nutrients that are out of reach of most crops and forage species, and this enables them to produce and retain high-quality green forage throughout the year," said Chenyambuga.

Chenyambuga directed the study with assistance from Margareth Kibodya, a laboratory technician who is undertaking her masters degree in Management of Natural Resources for Sustainable Agriculture. Kibodya has been actively involved in research focused on an agro-forestry management

...Local Plants continued on page 15

JULY WORKSHOP IN CHINA

Jim Diana

The AquaFish CRSP held a workshop on Aquaculture, Human Health, and Environment in Shanghai, China from 7-10 July 2009. Over 28 people attended, including faculty, students, and staff from all the CRSP Asian host country universities partnered with the University of Michigan project, as well as staff from the World Wildlife Fund. The atmosphere of the workshop was saddened by the deteriorating health condition of its creator, Professor Yang Yi, who could not attend the workshop. His health was constantly on our minds. Professors Liu Liping and Min Jiang substituted for Yang Yi and made the arrangements for hosting by Shanghai Ocean University. The workshop served as a wonderful venue for members of AquaFish CRSP research projects to review their progress, discuss future plans, and consider the relationship between their research program and needs within their countries.

The first day of the workshop presented an opportunity for each project to summarize their results to date. Altogether, ten presentations were made on the results of research conducted by CRSP institutions. The quality of these presentations was a clear indication of the high quality of faculty, staff, and students working on the CRSP,

as well as the research questions in which they are engaged. There was a lot of discussion among CRSP participants about the kind of research being done in some countries and the kind that should move forward in other countries, as a result of the exchange of information and studies being conducted across the region.

The second day of the workshop focused on interaction among participants regarding the major issues related to aquaculture that should be a focus for our Asian research projects in the CRSP. This section was facilitated by Jim Diana. The first step of this process was for each individual to list on a piece of paper three issues they felt were important. Upon review of this list, we summarized the issues by various areas of work and combined similar areas into the overall list of research priorities. The priorities fell into four categories: aquaculture practices, fisheries, mitigating environmental impacts, and socio-economics. After compression of the topics, a total of 26 different areas of research were listed under these four categories.

Highest priority was given to studies on water quality and effluents, followed by microcystins, and a three-way tie for third place—sediment management, species introductions and impacts on indigenous species, and the quality of seed

...China Workshop continued on page 16



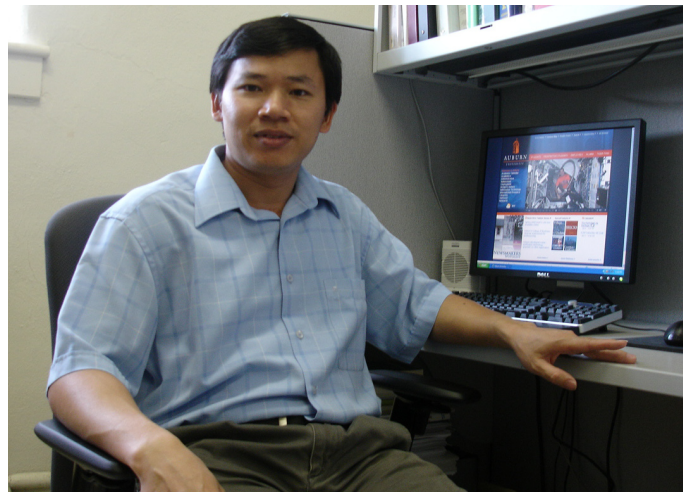
Workshop participants gather for a photo at Shanghai Ocean University. (Courtesy of Jim Diana)

BORLAUG LEAP FELLOW: MR. NHUONG VAN TRAN

With a diverse background in agriculture and aquaculture sciences, Nhuong Van Tran was recently awarded a Borlaug Leadership Enhancement in Agriculture Program (LEAP) Fellowship. Based at the University of California, Davis, this fellowship program is funded by USAID to enhance the quality of thesis research by graduate students from developing countries who show strong promise as leaders in agriculture related fields. The fellowship will allow Nhuong to conduct research for his PhD dissertation at Auburn University under the mentorship of his committee co-chairs, Dr. Conner Bailey and Dr. Norbet Wilson, and AquaFish CRSP Lead PI from the University of Connecticut, Dr. Robert Pomeroy. In collaboration with Dr. Pomeroy, Nhuong will be able to integrate his research with the AquaFish CRSP project in Cambodia and Vietnam, which focuses on enhancing trade opportunities for global fishery markets. Nhuong will also work with researchers at the WorldFish Center and The Research Institute for Aquaculture no.1 (RIA1) in Vietnam.

A Vietnamese student from Nghe An, Nhuong completed a BSc in aquaculture engineering, an MSc in Natural Resource Economics, and has over ten years of research experience with RIA1. In 2004 he received a grant from the International Institute for Fisheries Economics and Trade (IIFET) with supporting funds from the Aquaculture CRSP. This grant allowed Nhuong to attend the biennial IIFET conference in Tokyo to present the research he had been working on. It was this experience that inspired Nhuong to pursue his graduate studies in the US. When he received a three-year fellowship from the Ford Foundation in 2006, he started at Auburn University in the Department of Agriculture Economics & Rural Sociology in pursuit of a PhD in Agriculture Economics, an MS in Rural Sociology, and a statistics minor.

Nhuong's dissertation research entitled, "Impacts of Food Safety and Environmental Standards on Seafood Supply Chains from the South: Evidence from Vietnam," investigates the relationships between new food standards and the seafood industry of Vietnam. Approximately 90% of the exports from Vietnam go to countries in the North such as the US and Japan, where concerns



*Nhuong Van Tran working on his dissertation research in his office at the Department of Agricultural Economics and Rural Sociology, Auburn University.
(Courtesy of Nhuong Van Tran)*

for personal health and sustainability are increasing with regard to seafood production and consumption. These concerns are being realized in the form of new food safety and environmental standards for seafood in the global market. While these standards are intended to protect consumer health and improve the sustainability of seafood production, Nhuong realizes that they can also become non-tariff barriers (NTBs) to trade, potentially hurting small-scale aquaculture producers and seafood processors. Nhuong will complete his fieldwork in Vietnam, where he will conduct a series of surveys and interviews with over 100 fish farmers and other stakeholders in the seafood industry. Looking at this issue from a Northern perspective and from the Vietnamese perspective will help Nhuong understand whether these food standards will act as NTBs or serve as a catalyst to improve seafood and environmental quality in Vietnam and other similar regions.

In regards to his LEAP Fellowship, Nhuong says, "This fellowship will give me an excellent opportunity to use theories and knowledge that I learned from developed countries in diverse situations in developing countries, and to apply research instruments, methods, and innovative tools to analyze, evaluate, and address problems related to agricultural and rural development in Vietnam. I believe that my fellowship with the Borlaug LEAP Program will have practical impacts at a policy level in the Government of Vietnam to support sustainable agriculture development."



...Alternative Feeds continued from page 8

can often benefit from the addition of phytase, an enzyme that breaks down phytin.

Based on the URI work, we designed experiments to be done at Can Tho University in Vietnam on the replacement of fishmeal with plant proteins in diets for snakehead. In the first experiment, we replaced 0, 20, 30, 40, or 50% of the fishmeal in diets for *C. striata* with soybean meal plus essential amino acids (the 0% replacement was the control treatment using only fishmeal). For each of the replacement levels, we added either a) taurine, b) phytase, or c) neither. The results indicated that survival was statistically the same for all the treatments. Based on the growth results, however, we can say that soybean meal can replace fish meal at the 30% level without addition of phytase or taurine and at the 40% level with the addition of phytase. Addition of taurine had no effect. In the second experiment, we replaced 0, 10, 20, or 30% of combined fishmeal and soybean meal (phytase added) in diets for *C. striata* with rice bran. Rice bran is more available in Vietnam than is soybean meal. Again there were no differences in survival. Growth was significantly better in the 10% rice bran diet than it was in the control (0% replacement), but there were no growth differences between the control diet and the 20% or 30% replacement with rice bran.



Experimental tanks for snakehead at Can Tho University, Vietnam. (Courtesy of Robert Pomeroy)

Our experiments are continuing, and we are encouraged by the results so far. In terms of replacement levels of fishmeal with plant protein, our results are similar to those of investigators working with piscivorous fish around the world. In order to demonstrate to farmers the utility of pelleted diets, we are currently examining the levels

at which “small fish” can be replaced by pelleted diets. We will continue to present our results at annual meetings of AquaFish CRSP, at World Aquaculture Society meetings (results of the first experiment were presented at Aquaculture America in Seattle in February, 2009), and by direct outreach to the farmers in Vietnam as part of this project. The decline in fish production in the Mekong River and Tonle Sap system might be alleviated by the reduction of fishing for small fish for use in aquaculture. Development of alternative feeds to small/trash fish could also allow snakehead culture in Cambodia to proceed.



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system that combines the growing of trees with the management of aquatic life--aquasilviculture. She evaluated *M. oleifera* and *L. leucocephala* as protein sources in tilapia (*Oreochromis niloticus*) diets as possible replacements for the relatively expensive soybean meal. The investigators believe that *L. leucocephala* leaf meal and *M. oleifera* leaf meal can be used in fish diets to substitute soybean meal at levels not more than 25 percent to reduce the cost of feed.



For more on Margareth Kibodya please see page 7

SOFT SHELL CRAB FARMING WORKSHOP IN BANDA ACEH

With support from the AquaFish CRSP project “Training in Sustainable Coastal Aquaculture Technologies in Indonesia and the Philippines,” and with co-sponsors Aquaculture Without Frontiers (AWF) and the Australian Centre for International Agricultural Research (ACIAR), the Soft Shell Crab Farming workshop was held in Banda Aceh, Indonesia 19-25 July 2009 at the Aceh Aquaculture Rehab project. AquaFish Lead PI Kevin Fitzsimmons and his graduate student Rafael Matinez-Garcia of the University of Arizona both were involved. The workshop provided information on soft shell crab farming as an alternative to raising shrimp. With sustainability problems arising in the region’s abundant shrimp farms, soft shell crab may be a more profitable, more sustainable, and a more socially equitable product for the surrounding communities.

AQUAFISH CRSP AT OREGON STATE'S UNIVERSITY DAY



AquaFish CRSP student employees pose in front of the AquaFish booth at the OSU University Day 2009. (Dwight Brimley)



Jim Bowman looks over the AquaFish booth as the day's events commence. (Dwight Brimley)

An event to open the school year at Oregon State University, University Day is a chance for campus-wide organizations to exhibit their programs. The AquaFish CRSP Management Team at OSU hosted a booth at the event expo on 24 September 2009. The AquaFish CRSP team engaged participants with program accomplishments and sustainable seafood choices, providing the opportunity for people to see what AquaFish CRSP is all about.

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in hatchery management. Already, participants from different countries have agreed to sample algal material from their ponds and lakes and provide them for the studies on microcystins. Such cooperation will be an important component of integrating the CRSP across the regions of Asia in the next two-year implementation plan..

Upon completion of the prioritization of research goals, participants went on tours of Shanghai, including interaction at Shanghai Ocean University with the president of the university and several faculty members.

On termination of the workshop, several CRSP members traveled to Chengdu to visit Professor Yang Yi. While he was quite ill, we were able to speak with him for some period of time and to inform him of the results of the workshop, as well as plans for our proposal. These had been serious issues on Yang Yi's mind, and it was heartening to see him engaged in this area and interested in its outcome. Unfortunately, he passed from this world two weeks after the workshop ended. While he is no longer with us, he clearly has a spiritual significance to all members of the Asian community of the AquaFish CRSP.



PONDERINGS...

"The Marginal World"
Rachel Carson

Only the most hardy and adaptable can survive in a region so mutable, yet the area between the tide lines is crowded with plants and animals. In this difficult world of the shore, life displays its enormous toughness and vitality by occupying almost every conceivable niche. Visibly, it carpets the intertidal rocks; or half hidden, it descends into fissures and crevices, or hides under boulders, or lurks in the wet gloom of sea caves. Invisibly, where the casual observer would say there is no life, it lies deep in the sand, in burrows and tubes and passageways. It tunnels into solid rock and bores into peat and clay. It encrusts weeds or drifting spars or the hard, chitinous shell of a lobster. It exists minutely, as the film of bacteria that spreads over a rock surface or a wharf piling; as spheres of protozoa, small as pinpricks, sparkling at the surface of the sea; and as Lilliputian beings swimming through dark pools that lie between the grains of sand.

Excerpted from Rachel Carson's *The Edge of the Sea* pages 1-2

Boston, Mass.: Houghton Mifflin Co., 1998.

Notices of Publication

Notices of Publication announce recently published work carried out under Aquaculture CRSP sponsorship. To receive a full copy of a report, please contact the author(s) directly.

ECONOMIC AND RISK ANALYSIS OF TILAPIA PRODUCTION IN KENYA (09-250)

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Kenya

Commercial production of tilapia in Kenya has potential for expansion, but growth and development of the tilapia industry in Kenya will depend upon its profitability and the effect of associated risks. Data from pond experiments, on-farm trials, and farm surveys were used to develop enterprise budgets and a risk analysis for nine production scenarios. The nine scenarios include: 1) monoculture of sex-reversed male tilapia fed either rice bran, a pelleted experimental diet, or a pelleted pig finisher diet; 2) clarias monoculture fed with each of the three diets; and 3) tilapia-clarias (sex-reversed male fingerlings) polyculture fed with each of the three diets. Net returns/ha were highest for production with the pig finisher diet, with clarias in monoculture the highest followed by tilapia in monoculture and then the polyculture system. The lowest net returns/ha were obtained with clarias fed rice bran. Profitability was affected by feed cost and tilapia survival. Tilapia monoculture systems had lower probabilities of financial losses than either clarias monoculture or the polyculture system. Use of the pelleted diets also resulted in lower probabilities of financial losses. Lower yields from the rice bran feed scenario resulted in its greater sensitivity to fluctuating costs of rice bran and survival of tilapia.

This abstract is excerpted from the original paper, which was published in *Journal of Applied Aquaculture*, 21:1-23.

INFLUENCE OF THE PHOTOPERIOD ON GROWTH RATE AND INSULIN-LIKE GROWTH FACTOR-I GENE EXPRESSION IN NILE TILAPIA *Oreochromis niloticus* (09-251)

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The effects of the duration of the light phase photoperiod (8 h light or 16 h light) on the growth and hepatic insulin-like growth factor-I (IGF-I) gene expression in Nile tilapia *Oreochromis niloticus* were evaluated. There was a slight but not significant tendency for fish in the long light phase group (LP) to display elevated specific growth rate (G) both in mass (M) and standard length (LS) compared with that in the short light phase group (SP; $P = 0.057$ for GM; $P = 0.055$ for GL). Significantly, higher food conversion efficiency was observed in the LP than in the SP. There were significant positive correlations between IGF-I concentrations and G, both in M and LS. A significantly negative correlation was observed between IGF-I mRNA level and eye color pattern. The lack of significant differences in G and hepatic IGF-I gene expression, despite the significant difference in feed conversion efficiency, may be related partly to the development of different levels of social interactions in the different groups within a photoperiod regime leading to increased variation of results within each group. These findings suggest that hepatic IGF-I gene expression has potential utility as a growth rate indicator for this species of fish and social status, as quantified by eye color pattern, appears to be a much stronger determinant of growth rate and IGF-I transcript level than does light phase photoperiod length.

This abstract is excerpted from the original paper, which was published in *Journal of Fish Biology* 75:130-141 and online at www.laserwords.co.in/offprint/jfb75-1/jfb2271.pdf

Upcoming Meetings and Events...

The AquaFish CRSP is proud to support workshops and meetings designed to facilitate increased knowledge and communication in aquaculture. Meetings and workshops coming up include..

Aquaculture 2010

1-5 March 2010

San Diego, California

www.was.org/WasMeetings/meetings/

AquaFish CRSP Annual Meeting

Sunday 28 February 2010

CRSP Impact Assessment Workshop

Monday 1 March 2010

San Diego, California

22nd International Conference of the Coastal Society

Shifting Shorelines: Adapting to the Future

13-16 June, 2010

Wilmington, North Carolina, USA

www.thecoastalsociety.org/conference/tcs22/index.html

IIFET 2010

12-16 July 2010

Montpellier, France

oregonstate.edu/dept/IIFET/

9th International Symposium on Tilapia in Aquaculture (ISTA9)

April 2011 (Tentative)

Shanghai Ocean University

Shanghai, China

ag.arizona.edu/aqua/ista/ISTA9/ISTA9.htm

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

SIDEBAR (continued from Yang Yi tribute on page 2)

The aquaculture system that Yang Yi named a cage-cum-pond system strives to reclaim as many applied nutrients in the fish crop as possible, while remaining simple and inexpensive so that small-scale farmers can adopt it. Such a system works well to intensively grow tilapia as efficiently as possible. His cage culture system was a success. The optimum design used two cages (each 2 m³), with 50 tilapia/m³ in each cage. Fish were stocked at 120 g, and grew to over 500 g in 3 months. Total production of tilapia in cages was about 19 tons per hectare per year, with a market size of about 450-500 g. Stocked tilapia (at 5 g) in the open pond resulted in a total net yield of about 6 tons per hectare per year of fish at 120 g. These could either be used to stock the cages or grown slightly larger for local consumption. For the pond overall, the feed conversion ratio was about 1.22. Of the nutrients applied, 21% of the nitrogen and 28% of the phosphorus was recovered in fish. Listed below are the publications resulting from the cage-cum-pond research of Yang Yi.

Yang Yi. 1999. Modeling growth of Nile tilapia (*Oreochromis niloticus*) in a cage-cum-pond integrated culture system. *Aquacultural Engineering* 21:113-133.

Yang Yi and C.K. Lin. 2001. Effects of biomass of caged Nile tilapia (*Oreochromis niloticus*) and aeration on the growth and yields in an integrated cage-cum-pond system. *Aquaculture* 195:253-267.

Yang Yi, C.K. Lin, and J.S. Diana. 1996. Influence of Nile tilapia (*Oreochromis niloticus*) stocking density in cages on their growth and yield in cages and in ponds containing the cages. *Aquaculture* 146:205-215.

Yang Yi, C.K. Lin, and J.S. Diana. 2003. Hybrid catfish (*Clarias macrocephalus* x *C. gariepinus*) and Nile tilapia (*Oreochromis niloticus*) culture in an integrated pen-cum-pond system: growth performance and nutrient budgets. *Aquaculture* 217:395-408.



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Aquanews is available on-line at aquafishcrsp.oregonstate.edu/aquanews.php. A downloadable *Aquanews* archive is also available on-line at aquafishcrsp.oregonstate.edu/AquaNewsArchives.php

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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