AQUANEWS

Sustainable Aquaculture for a Secure Future

POND DYNAMICS/AQUACULTURE COLLABORATIVE RESEARCH SUPPORT PROGRAM NEWSLETTER

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CRSP Activities in the Africa Region

We devote much of this issue to the PD/A CRSP in Africa. An overview of current investigations and collaborating partners appears on the following page, with additional information on these available at the CRSP website (see Publications section "Tenth Work Plan"). See p. 10 for a story on a new InterCRSP Njoro River watershed management project.

Use of Local Technology to Promote Aquaculture Development in Sagana, Kenya

by D. Liti and J. Munguti
Moi University and Sagana Fish Farm, Kenya

Sagana and the CRSP

PD/A CRSP activities at Sagana Fish Farm have greatly enhanced the reputation and visibility of Sagana's research in sustainable aquaculture.

In the current PD/A CRSP work plan, research at Sagana is aimed at improving production of fish protein and fish seed. Two investigations are underway: 1) Evaluation of Growth and Reproductive Performance of Three Strains of Nile Tilapia, *Oreochromis niloticus*, Found in Kenya for Use in Aquaculture; and 2) Development of Economically Feasible Feeds for Semi-Intensive Culture of Tilapia, *Oreochromis niloticus*, Using Locally Available Agricultural By-Products.

…continued on p. 4

MWANGI MBUGUA

Aquaculture ponds at Sagana Fish Farm, Kenya.

Sagana Fish Farm

by D. Liti and J. Munguti
Moi University and Sagana Fish Farm, Kenya

Recent History

Improvement of Sagana Fish Farm has been at the center of aquaculture development in Kenya since 1993. Rehabilitation of the farm started then, under the sponsorship of a project funded by the Belgian Government. Renovation of old ponds as well as construction of new ones took place through 1996. In 1997, the PD/A CRSP project was initiated at Sagana. Farm operations under both projects were partly funded by the Government of Kenya. Sagana now has 109 ponds, 65 ponds of which were constructed specifically for research purposes, with the balance being used for spawning, fingerling production, and growout of fish.

The Farm as a Training Center

Sagana is a busy station characterized by many visits from farmers, government officers, students from primary, secondary, and university institutions, and local as well as international scientists. Last year Sagana hosted Jonathan Munguti, a Kenyan, and Richard Nyamwihura, a Tanzanian, for four months during their M.S. research periods. Both were participating in an international academic program in limnology and wetland ecosystems, and their stay was sponsored and Austrian Academy of Sciences and The Netherlands' International Institute for Infrastructural, Hydraulic and Environmental

…continued on p. 4

Kenyan Regional Enterprise Budget and Business Plan Development

by Carole Engle, University of Arkansas at Pine Bluff, and Mucai Muchiri, Moi University

KEVIN FITZSIMMONS

Aquaculture facilities at Moi University, Eldoret, Kenya.

There is a great deal of interest in the development of successful aquaculture businesses in the East Africa region. Researchers at the University of Arkansas at Pine Bluff and Moi University, Eldoret, Kenya, are collaborating in the development of enterprise budgets for both tilapia monoculture and tilapia–*Clarias* spp. polyculture. Budgets will be developed for cash systems based on on-farm inputs and for commercial systems based on purchased feeds and fertilizers. The enterprise budgets developed will be published for distribution with instructions to farmers on how these can be adapted to their particular situation and farm.

From the enterprise budgets, pro forma financial statements (including annual cost and returns, estimate of total required capital, balance sheets, income statements, and cash flow budgets) will be developed for the production systems and average farm sizes selected. The financial statements will be published with instructions containing a spreadsheet for farmers to enter farm-specific data as needed.

A summary of marketing information will be prepared for each of the production systems/scenarios proposed. Fundamental market information required to present the market plan component will be included. This will include information on prices, product forms, market channels, volume requirements for various market channels, and potential target market segments. Economic planning tools such as these under development in Kenya will assist existing and prospective tilapia farmers to increase the likelihood of developing successful businesses

continued on p. 11...

2002 Portfolio of PD/A CRSP Investigations and Collaborating Partners in Africa

Development of Economically Feasible Feeds for Semi-Intensive Culture of Tilapia, *Oreochromis niloticus*, Using Locally Available Agricultural By-Products

Moi University, Kenya
Fisheries Department, Kenya
Auburn University, US

Techniques for the Production of *Clarias gariepinus* Fingerlings as Baitfish for the Lake Victoria Nile Perch Longline Fishery

Moi University, Kenya
Fisheries Department, Kenya
Auburn University, US
Oregon State University, US

Evaluation of Growth and Reproductive Performance of Three Strains of Nile Tilapia *Oreochromis niloticus* Found in Kenya for Use in Aquaculture

Moi University, Kenya
Fisheries Department, Kenya
Auburn University, US

Aquaculture Training for Kenyan Fisheries Officers and University Students

Moi University, Kenya
Fisheries Department, Kenya
Auburn University, US
Oregon State University, US

Regional Enterprise Budget and Business Plan Development; and Economic and Risk Analysis of Tilapia Production in Kenya

Moi University, Kenya
University of Arkansas at Pine Bluff, US

Reaction of Liming Materials in Pond Bottom Soils, South Africa

University of Stellenbosch, South Africa
Auburn University, US

Kenya's Director of Fisheries Department Visits the US

By Steve Sempier

Nancy Gitonga, Director of the Kenya Department of Fisheries, recently returned home after spending several weeks in the United States. Highlights of her trip included attending an American Fisheries Society (AFS) conference, visiting with United States Agency for International Development (USAID) officials, and touring several US universities and fish farms.

STEVE SEMPIER

Kenya Fisheries Department Director Nancy Gitonga at AFS meeting in Baltimore earlier this year.

Gitonga gave a well-received poster presentation at the 132nd Annual Meeting of the American Fisheries Society. The poster focused on aquaculture development in Kenya. Gitonga attended the meeting, which took place from 18 to 22 August 2002 in Baltimore, Maryland. During the meeting she met many current and potential future PD/A CRSP collaborators. In addition, she attended numerous presentations that addressed fisheries issues and challenges that also face Kenyan fisheries.

After the AFS meeting, Gitonga traveled to Washington, DC. At USAID, she gave a presentation titled, "The Role of Aquaculture in Fisheries Development in Kenya." The USAID officials who attended the 23 August 2002 presentation expressed great interest in the subject.

In addition to Gitonga's time in Baltimore and Washington, she spent time at The Ohio State University in Columbus and at the University of Arkansas at Pine Bluff. These visits allowed Gitonga to spend time at US universities that are collaborating with the CRSP and expand the Kenya Department of Fisheries network. While in Arkansas, Gitonga also visited several aquaculture farms that cultured a variety of species. She noted the similarities and differences between these farms and farms in Kenya. Those tours may open up more doors for opportunities in Kenya.

Gitonga's CRSP-sponsored trip was a success as she was able to both build upon and strengthen her network of US contacts in the fisheries and aquaculture field. In addition, she was able to share concerns and successes related to aquaculture in Kenya and foster interest in pursuing aquaculture research in this region of Africa.

Optimizing Lime Use in Aquaculture Ponds– CRSP Work in South Africa

Researchers Claude Boyd and Wes Wood, both from Auburn University, are collaborating with Danie Brink, University of Stellenbosch, South Africa, in an investigation that seeks to maximize the effectiveness of lime applied to aquaculture ponds.

Lime is used to increase alkalinity in aquaculture ponds, which in turn encourages the growth of the plant life upon which certain types of fish, including tilapia, feed.

The experiment involves treating ponds in a variety of ways. Specifically, treatments include: 1) applying agricultural limestone over pond water surface after filling; 2) applying agricultural limestone over pond bottom before filling; 3) applying agricultural limestone over pond bottom followed by tilling of soil before filling; and 4) control (no agricultural limestone added).

To obtain values for alkalinity and hardness, researchers collect weekly water samples. Soil cores are collected on a monthly basis and divided into 2 cm-long segments; these will be analyzed for pH and exchangeable acidity.

These experiments are being duplicated in Jaguariuna, Brazil. When this work is complete, data will be available for coarse textured (South Africa) and fine textured (Brazil) soils regarding the influence of lime application method on neutralization of acidity in ponds.

These data will allow the scientists to formulate recommendations on appropriate application methods to maximize effectiveness of lime applied to aquaculture ponds. Beneficiaries of results obtained in this research effort include not only farmers near CRSP sites, but those in neighboring countries as well.

Auburn University and the University of Stellenbosch have co-signed a Memorandum of Understanding and an Academic Interchange Agreement.

Use of Local Technology to Promote Aquaculture Development in Sagana, Kenya

by D. Liti and J. Munguti

...from p. 1

Sagana Investigations

Evaluation of Growth and Reproductive Performance

Three Nile tilapia strains from Lake Victoria, Lake Turkana, and Sagana are being evaluated to determine the best strain that can be recommended to farmers. Although the strain experiment is in its initial stages, there are indications that the Lake Victoria strain may have the best performance in terms of growth.

Development of Economically Feasible Feeds

Single ingredients of agricultural by-products—wheat bran, maize bran, and rice bran—have been evaluated and recommended to farmers. Wheat and maize bran have proved through previous experiments to be better feed supplements for Nile tilapia than rice bran. The latter performed poorly due to adulteration by the suppliers. In fact, rice performed only marginally over the fertilizer treatments despite having the same cost per unit weight as the other two brans.

In addition to the single ingredients, locally available commercial feeds have also been evaluated as feed supplements for Nile tilapia. Research at Sagana has established that diets formulated for pigs perform as well as the commercial diets formulated for tilapia. Moreover, as pig diets are cheaper than tilapia diets, their use increases profitability.

Analysis of commercial feeds conducted at the Sagana laboratory has shown that some commercial feeds do not meet the specifications given by the manufacturers. Moreover, the feeds are unreasonably expensive.

Students' Short-term Experiments at Sagana Yield Tangible Benifits

In parallel with longer-term research investigations, side experiments are conducted at Sagana by undergraduate students in fulfillment of their senior projects. Results from these experiments have been quite interesting. In one instance, ponds were treated with lime and common salt to simulate the well known productive soda lakes, of which Lake Turkana in Kenya is an example. The student project demonstrated that treatment of limed earthen ponds with common salt lead to a remarkable increase in fish growth.

Sagana Fish Farm

...from p. 1

Engineering. Collaborating East African host institutions were Egerton and Moi Universities in Kenya, Makerere University in Uganda, and the University of Dar es Salaam in Tanzania. Sagana played a key role in this program as a site for the research, as well as providing guidance to the students.

Support to the Community

Since the late 1990s, Sagana has emerged as a center of excellence in aquaculture, not only in Kenya but also throughout East and Central Africa. Research activities have contributed a great deal in providing farmers with quality seeds, knowledge about fish feeds, and advice on the economic use of fertilizers and fertilization rates. These, together with provision of quality protein, have played a key role in uplifting the living standards of the local people. Protein malnutrition, mainly among children, has been reduced to a great extent. The farm is also a source of inspiration to those farmers who wanted to venture in small-scale commercial fish farming. The introduction of communal fish farming, mainly by women groups in the Central and Eastern provinces of Kenya, has immensely improved their income. Public awareness and change of attitudes towards fish farming and fish consumption, especially to those communities living away from capture fishery areas, and which previously did not appreciate fish farming, have successfully been achieved. This has been done through extension services and frequent organization of field days.

MWANGI MBUGUA

The Sagana feed mill.

Aquaculture in Kenya

by D. Liti and J. Munguti

Kenya's aquaculture is based on warm water, cold water, and marine culture. The industry is supported by three major aquaculture farms: Sagana, Ngomeni, and Kiganjo. These provide fish seed, fish food, training, research, and extension services. Tilapia culture in Kenya is carried out basically at a subsistence level and is widespread throughout the country. Trout farming is not as prevalent, being currently confined to a few commercial farms near Mt. Kenya, while shrimp farming has not taken off despite the funding of the Ngomeni project by the United Nations Food and Agriculture Organization and the United Nations Development Programme.

At the community level, interest in aquaculture is just beginning to emerge with many farmers making inquiries on whether the industry can generate adequate profits to improve their economic bases.

Major constraints that have contributed to the slow development of aquaculture in Kenya include inadequate knowledge of how to raise aquacultural animals, lack of quality fish seed, lack of cheap and high quality diets, and inadequate extension services. Another major problem is the lack of locally made—and thus affordable—equipment.

MWANGI MBUGUA

The mixer has a capacity of 1.5 m^3 and can mix 50 kg of feed at a time. It is manually driven by using a well designed handle. It can also be adapted to be operated by a gasoline engine or electrical power. J. Kariuki, Sagana, demonstrates.

Jua-Kali

by D. Liti and J. Munguti

The feed experiment (opposite top left) has taken an interesting direction by delving into so-called appropriate technology. Two important pieces of equipment, a pelleter and a mixer, have been successfully developed. The two were developed with the help of an informal sector, locally known as *Jua-Kali*, and are designed to meet local needs for easy service and maintenance.

Jua-Kali is a local name which literally means "hot sun," and is given to enterprises that work with metal and wood materials. The industry, though small in scale, plays an important role in the livelihoods of many Kenyans. The *Jua-Kali* sector makes good, inexpensive tools and equipment from scrap metal and with limited resources. The history of the *Jua-Kali* in agriculture development in Kenya is well known and is well represented in the production of agricultural tools and equipment.

Most of the *Jua-Kali* equipment in the agricultural sector meets the designs and specifications of the sector. Up until now the aquaculture sector has not benefited much from the industry. The turnaround came earlier in this current work plan, when *Jua-Kali* was engaged to develop a pelleter and mixer. The two have attracted the attention of farmers with two of them placing orders for the pelleter and many others venturing into making their own mixers.

MWANGI MBUGUA

The pelleter resembles a meat mincer and is driven by a single phase 1.5 hp motor. It was developed in collaboration with the engineering company East African Foundry Works in Nairobi. The first of its kind to be made by local artisans, it has a capacity to produce approximately 30 kg pellets of feed per hour. J. Kariuki, Sagana, is pictured.

Farmers Appreciative of Lessons Learned during On-farm Trials

by Karen Veverica, Auburn University

On-farm testing is a logical step in transferring research-based technologies to the farm, as it allows farmers to assess their costs and benefits under local conditions as well as to receive instruction and training in basic pond management skills. It also allows project personnel to work with and train the fisheries extension officers, complementing the experience the extension officers gain through formal training activities.

CHARLES NGUGI

Ponds at a small-scale aquaculture farm, Kenya.

In a collaboration among Oregon State University, Auburn University, Moi University, and Sagana Fish Farm, on-farm trials were conducted in Central, Eastern, Rift Valley, and Western Provinces, Kenya.

Although the technical advice was useful and important, participants' attitudes towards business is what made these trials so successful. The only services provided by the CRSP project were transport of fingerlings, visits to offer technical advice, and help with sampling.

Farmers were required to purchase all of their own inputs, including fingerlings. This was a difficult pill to swallow for many farmers. Nonetheless, as a result of having a personal investment at stake, at the end of the trials, many farmers presented their data as expenses and revenues rather than just the weight of fish harvested.

One farmer stated that his father had never earned a single shilling from his aquaculture ponds in more than 10 years. However, because of these trials, in just one harvest the son ended up with 10,000 KSh in his pocket. He went on to explain that over the years, with the many extension projects promoting fish farming and providing farmers with inputs at no cost, everyone always thought of aquaculture more as a hobby than a serious business enterprise.

As a result, neighbors—that is, potential customers—figured the harvested fish should be given away for free as well. Thus, although the farmers did not invest much in the way of real capital, they still did a lot of work and never reaped any financial benefit. The CRSP on-farm trials made it possible for this farmer to convince his neighbors that his aquaculture ponds were now a bonafide business venture.

CHARLES NGUGI

Pond harvest during on-farm trials.

FOLLOWING THE FINAL MEETING OF FARMERS FOR THE ON-FARM TRIALS IN WESTERN KENYA, PARTICIPANT MR. MORRIS ROBERT OMUHAYA RETURNED HOME AND WROTE LETTERS TO PROJECT STAFF MEMBERS JUDITH AMADIVA AND KAREN VEVERICA EXPRESSING HIS APPRECIATION FOR WHAT HE LEARNED DURING THE ON-FARM TRIALS.

HE WROTE:

I have improved on my fish farming enterprise through your good advice and lectures. I've now stocked my ponds for the next season and I'm going to improve on pond inputs so that I get [even better] profits than [those] I got in the on-farm trials...

My son is going to sit in this year's O-level exams just because of these fish ponds which have become my only financial resource.

Aquaculture Experts Convene in Nairobi

The PD/A CRSP convened the third and last of a series of regional expert panel meetings in July 2002 in Nairobi, Kenya.

Africa Expert Panel members were selected based on their area of expertise and disciplinary focus, region, and gender. Expert Panel members, among them three women, included biologists, social scientists, and engineers. Individuals hailed from Egypt, Burkina Faso, Nigeria, Ghana, South Africa, Kenya, Malawi, and Congo. As panel members their objective was to participate as representatives of the region as a whole rather than of subregions.

The panel meeting took place on 8 July. After the meeting, many of the panelists participated in a tour of the Sagana Fish Farm, just northeast of Nairo-bi, and of Moi University in Eldoret, which is several hundred miles to the northwest.

The PD/A CRSPs current grant extends through July 31, 2003. In 2001, the PD/A CRSP convened a Proposal Planning Executive Commit-tee (PPEC), whose objective is to coordinate and lead the planning effort for the next continuation proposal to USAID. The first phase of information gathering was a stakeholder meeting held in Honduras in August 2001.

KEVIN FITZSIMMONS

KEVIN FITZSIMMONS

GWYN NEWCOMBE

Africa Region Expert Panel Members, from top left:
Mucai Muchiri
Aboubacar Toguyeni
J.F. Baroiller
Stella Williams
Fatma Hafez
Pierre Justin Kouka
Kwamena Quagrainie
Daniel Jamu
Danie Brink
Nancy Gitonga

GWYN NEWCOMBE

Panel members visited Sagana Fish Farm and Moi University after the Expert Panel Meeting in Nairobi. Above they tour ponds at Sagana.

The second phase of information gathering involved three expert panel meetings for the Latin America and Caribbean Region, Asia Region, and Africa Region. Each panel had 10 experts, as well as a chair and a facilitator from PPEC. Panel members came to the meeting having previously reviewed a broad selection of relevant literature.

Panelists were asked to consider, "What are the issues that constrain small-holder fish farms from becoming more successful in the [relevant] region?") and "What are the researchable priorities arising from these constraints?" Based on the constraints and researchable priorities identified in each of the three panels, the PPEC developed a synthesized set of global researchable priorities both for a five-year proposal and for the Request for Proposals for the Eleventh Work Plan. (Proposals submitted in response to that RFP are currently undergoing panel peer reviews.)

The Expert Panel meetings for the Latin America and the Caribbean Region and for the Asia Region took place respectively in San Diego, California, in February, and Beijing in April.

Culture of Mollusks to Improve Human Protein Intake in the Amazon Region

by Fernando Alcantara and Salvador Tello, Instituto de Investigaciones de la Amazonia Peruana, and Christopher C. Kohler, Susan T. Kohler, and William Camargo N., Southern Illinois University, Carbondale

Mollusks Offer an Alternative to Fish-based Aquaculture

The Amazon River region contains a high biodiversity of aquatic organisms hence an excellent potential for commercial aquaculture. The sustainability and expansion of aquaculture in Amazonia will be fostered by establishing new species for cultivation. Invertebrates, in particular, have received minimal attention in this regard. Several species of mollusks (gastropods and bivalves) have been exploited irregularly by the ever-declining commercial fishing industry in the Amazonian region. Currently, research is underway by the Instituto de Investigaciones de la Amazonia Peruana (IIAP) in Iquitos and Pucallpa, Peru, to develop simple technologies to culture aquatic and giant terrestrial gastropods as an alternative form of polyculture or integrated aquaculture.

Churo is a Promising Candidate

Applesnails (*Pomacea* spp.)—and among them *P. maculata*, or *churo*, as it is known in Peru—are the largest known freshwater gastropods, reaching lengths of 155 mm and diameters of 135 mm (Pain, 1960). This aquatic organism lives in the floodplain of the Amazon region (Cobos, 1998), preferring the zone where water mixes in the major and minor rivers (hardness from 35 to 256 mg l^{-1}) as well as in their tributaries (Villacorta, 1976). It is a species of periodic reproduction (Cobos, 1998), depositing its eggs in clusters outside the water on hard surfaces (e.g., trees, shrubs, wood debris), most frequently in the flooding months (rainy season). The number of eggs produced per female at each spawn varies according to body size, ranging from 233 to 1,425 eggs (Cobos, 1998; Rojas and Mori, 1976; Villacorta, 1976). Ontogenic development takes from twelve to sixteen days (Alcántara et al., 1996) and hatching rate is 87% (Cobos, 1998). Churo is omnivorous, feeding either on fresh or partially decomposed organic matter, including floating macrophytes (e.g., water lettuce or huama–*Pistia stratiotes*, duckweed–*Lemna minor*), rooted plants (e.g., gramalote–*Paspalum* spp.), tree leaves (e.g., renaco–*Ficus guianensis*, cetico–*Cecropia* spp., tangarana–*Paniculata tachigalia*, catahua–*Hura crepitans* and quinilla–*Vochysia lomatophylla*) and shrubs (e.g., ñejilla–*Bactris* sp. and water chestnut or rayabalsa–*Montrichardia* spp.) in the natural environment (Cobos, 1998).

Churo is a hardy species that readily adapts to controlled environments and reproduces in captivity. The egg-laying characteristics facilitate egg collection under culture conditions. In Iquitos, churo culture is conducted by IIAP in aquaria or in cement tanks slightly filled with water (15 cm depth). These are covered with a lid made of a wooden frame layered with a fine

…continued on p. 11

ROGER HARRIS

Pomacea *eggs on tree trunk near Iquitos, Peru. [Image courtesy <www.junglephotos.com>.]*

STIJN GHESQUIERE

Adult Pomacea bridgesi. *[Image courtesy of <www.applesnail.net>.]*

Arapaima Pond Culture by the Small-Scale Fish Producers of the Peruvian Amazon

by Fernando Alcantara and Salvador Tello, Instituto de Investigaciones de la Amazonia Peruana, and Christopher C. Kohler, Susan T. Kohler, and William Camargo N., Southern Illinois University, Carbondale

PEDRO ICOMEDES

Biologist Palmira Padilla from IIAP (right) handing one of the six Arapaima *juveniles given to a beneficiary.*

Known as *paiche* in Peru and *pirarucu* in Brazil and Colombia, *Arapaima gigas* (Osteoglossidae) is one of the major scaled fishes in the Amazon and Orinoco watershed systems (Luling, 1969). It lives in lagoons and in the large rivers of the vast Amazon region in water with slightly acid pH that is typically black in color (owing to the presence of abundant decomposing plant material). In its natural environment, *A. gigas* reaches lengths from two to three meters and can weigh up to 200 kg (Saint-Paul, 1986), feeding mainly on live fish (Fontenele, 1942; Sánchez, 1961). The meat lacks intermuscular bones or spines, and each fish has a dressout yield of 57% (Imbirirba, 1986). The fillet is of excellent quality and is a highly prized favorite among the consumer of the Amazonian region.

A drastic population decrease in *A. gigas* is the result of intense capture pressure that the species has been under in its natural habitat. According to Guerra (1996), statistics on landings in the Department of Loreto, Peru, show that during high season *A. gigas* comprised 10% of the total fish capture from 1980 to 1992 but declined thereafter. The fishing pressure has placed the species at risk from a conservation and sustainable usage perspective; in fact, *A. gigas* is listed as endangered by the Convention on International Trade of Wild Fauna and Flora Species.

A. gigas has been able to reproduce naturally in medium-size ponds (Alcántara, 1990) and large water enclosures, feeding on small cultured forage fish (Bard et al., 1975; Alcántara & Guerra, 1992; Rebaza, 1998; Imbiriba, 2001) and cultivated with simple technologies that can readily be incorporated by the private sector. Furthermore, *A. gigas* under cultivation conditions accepts alternative foods, such as chicken embryos, pelletized feed (De Souza et al. 1986; Aldea, 2002; Village, 2002 unpublished; Sagratzki-Cavero et al., in press) and, in extreme conditions, bread and crackers (Rebaza et al., 1999).

Earlier this year, a nongovernmental organization (NGO) that has been working in the area of Iquitos, Peru, took cultured *A. gigas* products to the International Fair of Bremen, Germany, where the NGO determined demand in that market alone for *A. gigas* fillet to be around 60 tonnes per month.

PEDRO ICOMEDES

IIAP/CRSP Extensionist Carlos Chávez holding an Arapaima *juvenile.*

…continued on p. 14

Assessment and Initial Capacity Building for the Rehabilitation of the River Njoro Watershed, Kenya (SUMAWA)

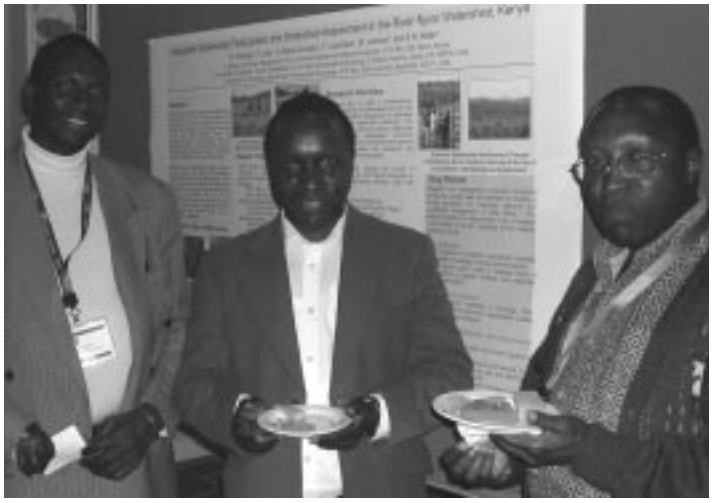
by Susan Johnson,
Global Livestock CRSP,
University of Califormia, Davis

The Pond Dynamics/Aquaculture CRSP and the Global Livestock CRSP have joined together to support a collaborative initiative for problem model assessment and human capacity building for the rehabilitation of the River Njoro watershed in Kenya. The multidisciplinary team is composed of faculty members from Egerton University, the University of Wyoming, the University of California at Davis and Moi University, as well as partners from other Kenyan institutions such as the Kenya Department of Fisheries and Kenya Wildlife Service.

The team is composed of four principal groups: watershed characterization, stakeholder involvement, ecology, and socio-economics, which will integrate stakeholder interests with scientific research and consult with various stakeholders in the watershed on matters such as water quantity and water quality. A watershed assessment will lead to the preparation of a problem model that will in turn facilitate the team to generate a full project proposal for integrated sustainable management of watershed resources through stakeholder participation at the watershed scale.

SUMAWA project participants met in Washington DC recently. Among them were Moi University professors Mucai Muchiri and Godfrey Monor. Muchiri is also a PD/A CRSP principal investigator.

SUSAN JOHNSON



The team for the joint PD/A CRSP and Global Livestock CRSP project (SUMAWA) recently presented a poster entitled "Integrated Stakeholder Participation and Watershed Assessment in the River Njoro Watershed, Kenya" at the GL-CRSP Program Conference. Pictured, from right, Ole Kamuaro Ololitisatti, Maasai Environment Resource Coalition, William Shivoga and Francis Lelo, Egerton University, SUMAWA project leaders.

After the meeting in Washington, Muchiri and Monor visited Oregon over the course of several days. Their visit, hosted by the PD/A CRSP, included meetings with staff at the Oregon Department of Environmental Quality in Portland. At Oregon State University they met with CRSP Director Hillary Egna, Fisheries and Wildlife Department Head Dan Edge, and CRSP Kenya Project OSU Principal Investigator Jim Bowman.

SUSAN JOHNSON

SUMAWA team member Prof. Aboud, Dean of the Faculty of Environmental Studies and Natural Resources, Egerton University, is pictured with Adam Wolf of the GL-CRSP Livestock Development and Rangeland Science project in Central Asia, and Getachew Gebru and Solomon Desta, GL-CRSP Pastoral Risk Management (PARIMA) project in Ethiopia and Kenya. Prof. Aboud is also a team member on the PARIMA project.

EdOp Net a Window on Opportunities

EdOp Net has come a long way since the first issue in October 1996. With a mailing list of over 500 subscribers and over 1,200 visits per month to the website, EdOp Net has grown into a preferred resource for PD/A CRSP participants and others interested in current educational and employment opportunities in aquaculture. At the time of publishing there were approximately 100 opportunities posted on the website. If you know of any educational or employment opportunities in the aquaculture field, let us know.

EdOp Net is a great way to find new graduate assistants, postdocs, interns, or people with general experience in aquaculture, and it allows you to reach potential applicants from around the world. To subscribe electronically to EdOp Net or to post an opportunity, email Ian Courter at <courteri@onid.orst.edu>; you can also see listings on our website, <pdacrsp.orst.edu/edops/edop.html>.

Graduate Student Profile: Jon Rauni

by Ian Courter

Kenyan Jon Rauni began work with the Pond Dynamics/ Aquaculture CRSP in February 2002. Just two months later he began working on his masters degree in aquaculture at Moi University, Kenya. Rauni's interest in pursuing his masters is attributed to his relationship with N.K. Kinyajui, who served as Sagana Fish Farm Head of Station at the time. After working with Rauni, Kinyajui advised him to develop his expertise in aquaculture. Rauni then applied for a CRSP scholarship through Moi University. After his application was accepted, Rauni dove into a rigorous schedule, balancing course work and thesis research under the supervision of PD/ A CRSP Host Country Principal Investigator, Charles C. Ngugi.

As a youngster, Rauni grew up fishing near his hometown, Meru, located on the slopes of Mount Kenya in the Samburu Region. His love for fishing kindled his interest in aquaculture. It is fitting that Rauni's CRSP research project is on *Clarias*, because he boasts a five hundred gram *Clarias* as his most prized catch while fishing. *Clarias*, a type of catfish, is Africa's most widely distributed fish.

Rauni expects his thesis project, titled "*Clarias* Fingerlings as Bait Fish," will take him about two years to complete. He is working with Ngugi, Jim Bowman, and Baraza Wangila to explore the issues surrounding *Clarias* culture. Their research focuses on maximizing *Clarias* fingerling production through alteration of shading regime, stocking density, and grow-out period. A recent increase in demand for *Clarias* fingerlings stems from longliners in popular fishing areas such as the Winam Gulf. *Clarias* is the preferred bait for longlining in Kenya, with an estimated demand between 5,000 and 50,000 fingerlings per fishing day. This amounts to a demand of 1.5 to 15 million *Clarias* fingerlings per year. *Clarias* is a naturally abundant species, dwelling most often under floating shoreline vegetation. However, capturing the fingerlings can be destructive to native cichlid populations. Due to the importance of the cichlid fishery in Kenya, beach seining and fishing with mosquito nets have been banned in Kenya. Rauni and his colleagues feel that successful aquacultural production of *Clarias* is just what the Kenya freshwater fishery needs, providing an inexpensive supply of bait fish without damaging wild fish populations.

When asked what makes Kenya an excellent place to develop aquaculture, Rauni replied, "An abundant water supply, cheap agricultural products, and an ideal tropical climate. Kenya has a long history of aquaculture and now has Sagana and Moi University as good research and training centers."

What does the future hold? After graduation Rauni hopes to continue research and further his education, particularly with respect to *Clarias*, a fish which he has become increasingly fond of. He believes that *Clarias* is an important species because of its widespread distribution throughout Africa, marketability, and potential as a biological control species.

Rauni recognizes the increasing importance of aquaculture worldwide, but he also knows when it's time to take a break from the hectic atmosphere of graduate school. When not in class or conducting aquaculture studies, Rauni finds himself fishing or relaxing to the melodious music of Charlie Pride and other country style favorites.

Kenyan Budget Development

...from p. 2

through adequate business planning and monitoring.

The proposed activity will produce enterprise budgets and pro forma financial statements for business plans that can be used as guides for prospective and existing fish farmers. A sound business plan is required by financial institutions before extending credit to any new enterprise. The information developed in this project will not only provide farmers with the appropriate tools to show profitability, but it will also help lending institutions to better assess the viability of aquaculture projects and reduce the rate of failure in loan repayment. Furthermore, this effort will identify the gaps in the existing database on fish farming in Kenya and the region.

Mollusks in Amazonia

...from p. 8

metallic mesh to provide a suitable surface for oviposition. Two weeks later, the eggs hatch and the juveniles fall into the water. At this time they are fed lettuce (*Lactuca sativa*, Villacorta, 1976; Sáenz, 2001), eggplant (*Solanum melongena*), squash or zapallo (*Cucurbita pepo*) and taro or pituca (*Colocasia esculenta*). In a six-month culture period, they reach a weight of 35 g and a length of 6.5 cm, with an average food conversion ratio (FCR) of 2.9. Further, Alcántara and Nakagawa (1996) conducted nutrition experiments using artificial feeds, obtaining variable yields between 8.1 to 31.8 kg m^{-2} in seven months of culture, with individuals averaging weights from 39 to 98 g.

The market size (proportional to culture period) can be reduced considerably to fit the requirements of international markets. Marketing the product as *escargot* (in Europe), for example, reduces the market size of the snails to only 4 cm in length, requiring only 2- to 3-months growth.

Another possibility is to use a value-added method such as canning, which IIAP and Southern Illinois University Carbondale under PD/A CRSP sponsorship have successfully produced using brine as the preservation media. This product is readily consumed by the locals to prepare *cebiche de churo*, a traditional dish. An economic study performed by IIAP determined profit margins of 58, 62 and 93%, at low (1,000 m^{-2}),

...continued on p. 15

Graduates' Corner

Congratulations to CRSP-sponsored graduate students Enos Mac'Were, Bethuel Omolo, and Robert Carpenter on completion of their degrees. In March 2002, Enos Mac'Were earned a Master of Science degree from the Fisheries Department of the Faculty of Forest Resources and Wildlife Management at Moi University, Kenya. His major professor was Charles Ngugi. Bethuel Omolo earned a Master of Science degree from the Department of Fisheries and Allied Aquacultures at Auburn University. A CRSP-sponsored graduate student profiled in the Summer 2000 issue of Aquanews*, he defended his thesis in November 2001. Ron Phelps was his major professor. Rob Carpenter, also advised by Ron Phelps, earned a Master of Science degree from the Department of Fisheries and Allied Aquacultures at Auburn University in August 2002.*

Comparison of tilapia and *Clarias* polyculture yields and economic benefits resulting from a locally available animal feed (pig finisher pellet), agricultural by-product (rice bran), and a pelleted test diet in fertilized ponds

(abstract of Enos Mac'Were's M.S. thesis)

Oreochromis niloticus and *Clarias gariepinus* were reared for 180 days in fertilized ponds receiving different feeds to compare growth and financial analysis. Supplemental feeds tested were a readily available agricultural by-product (rice bran), commercially available animal diet (pig finisher pellet), and a pelleted test diet. Test diet was formulated to contain 20% crude protein (CP). The two pellets were compared to rice bran.

Twelve 800-m^2 ponds, with four replicates for each of three feeds and fertilizer regimes were limed at 2.5 ton ha^{-1} just prior to filling with water. Each pond was stocked with 1550 tilapia and 50 *Clarias* averaging 89 g and 330 g respectively. Fish were fed twice a day at 10 A.M. and 4 P.M. at estimated 2% body weight. Each pond was fertilized at 5 kg P ha^{-1} wk^{-1} and 20 kg N ha^{-1} wk^{-1} from diammonium phosphate (DAP) and urea.

Water quality parameters were not significantly different ($p>0.05$) among treatments except total alkalinity in which TDP was higher than RB, and both dawn and afternoon pH and dissolved oxygen where ponds receiving RB and PFP had highest and lowest ($p<0.05$) values respectively.

All three feeds contained much lower protein than expected. Rice bran (RB) had 5% CP content against expected 10%. Pig finisher pellet (PFP) advertised to contain 14% had 10% while test diet pellet (TDP) had only 11%.

RB had significantly lower values ($P<0.05$) in fish growth rate, gross and net fish yields, net annualized production and with higher values on apparent feed conversion ratio compared to both PFP and TDP. However,

...continued on p. 14

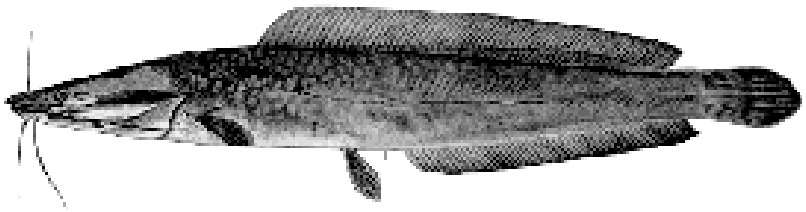


Image of Clarias gariepinus *courtesy of FishBase (<www.fishbase.org>), reproduced with permission from Dr. Guy Teugels, Royal Museum for Central Africa, Tervuren, Belgium.*

Graduates' Corner (cont.)

Feed Conversion Efficiency in Channel Catfish (*Ictalurus punctatus*) as a function of size

(abstract of Bethuel Oduor Omolo's M.S. thesis)

Research was conducted in 0.04-ha ponds at Auburn University Fisheries Research Station to study changes in feed conversion efficiency by channel catfish after reaching a minimum market weight of 250 g and assess the implications for economically optimum harvest weight. Fish from five nominal weight classes (250, 500, 1000, 1500, and 2000 g) were stocked in two randomly selected ponds per weight class and fed a 32% protein, floating feed once daily to apparent satiety. In order to maintain similar water quality in all ponds, the stocking densities were such that, based on existing bioenergetic models, predicted average daily feed consumption at water temperatures of 29°C would be near 50 kg/ha in all ponds. All observed mortalities were counted and weighed. Ponds were harvested when cumulative feed consumption exceeded 150% of initial fish biomass or 1600 kg/ha (average rearing time 86 d).

After harvest, fish were restocked to produce two additional replications of the 500-, 1000-, and 2000-g nominal weight classes, following the same feeding criteria. Four of the 16 ponds failed one or both inclusion criteria for further analysis (survival > 70% and fish recovery > 95% of initial stock). In the remaining 12 ponds, average water temperature was 27 C, fish weights were not related (each P >0.10; r^2 <0.20) to dissolved oxygen concentration at dawn (5.9 mg/L), survival (95%), recovery of stocked fish (99%), feeding rate (31 kg/ha-d), and standing crop of fish at harvest (3341 kg/ha). Feed conversion ratios (FCR, feed/gain) ranged from 1.47 to 3.54 and were related to fish weight (P<0.01, r^2=0.63). The relationship between FCR and average weight was described by the equation $FCR=1.41 + 0.54W_{kg}$. This relationship suggested that at current feed and fingerling

...continued on p. 15

Sex Determination and Inheritance of Sex Ratio in Families of *Oreochromis niloticus*

Abstract of Robert Harper Carpenter's M.S. thesis

Inheritance of sex ratio was studied using three strains of *Oreochromis niloticus* progeny sets from nine individual pair spawns, designated as families, from April to October of 2000. Five males were placed in hapas with half the females from their family and were allowed to spawn during the summer months. Ten sets of progeny from each family, eight from Family VI, were collected after at least sixty days of grow-out. Sex ratios of all 88 progeny groups were determined by microscopic examination of gonads. Sex ratio of each spawn was compared to that of the parent family, family mean, and population mean using Chi-square tests. Of the nine families, four produced progeny where 100% of the ten sets were significantly different from the parent ratio ($P < 0.05$). Of the other five families, four had 40 to 90% of the progeny sets different from the parent while Family VIII only reported 10% of the sets to be significantly different. Results of progeny sets when compared to the family mean, mean proportion of males for all that families spawns, revealed three families where 10% of the progeny sets were significantly different. The remaining families revealed 20 to 50% of progeny sets different from the family mean. Similar differences were found when comparing each spawn to the population mean. Calculations for heritability of sex ratio revealed an h^2 value of 0.09 with an R^2 value of 0.04. Results suggest sex ratio is not an inherited trait.

A temperature study was also performed on spawns from three families to determine the effect of environment on sex determination. Spawns were separated into equal groups at swim-up and one group was reared in temperature controlled aquaria at 35±1 °C for 30 days and the other at ambient temperature averaging 29±1 °C. High temperature skewed the sex ratio to male in two of the three families tested giving evidence that there was an environmental component in sex determination. This effect, however, is not always expressed.

Arapaima Pond Culture

...from p. 9

Arapaima Culture Program

Two years ago IIAP and Terra Nuova, an Italian NGO, joined together to initiate an *A. gigas* cultivation program that includes several small-scale producer ponds.

In this article we report the progress of the program, as well as the methodology used.

Objectives of the program are to:

- Develop the natural (non-induced) production of *A. gigas* (paiche) fingerlings from broodstock in the ponds of the small-scale fish producers along the Iquitos-Nauta Road in Loreto.
- Augment the supply of *A. gigas* fillets by producing diverse value-added products aimed at the growing international market.
- Enhance fingerling supply.
- Diminish *A. gigas* fishing pressure in its natural habitat.
- Contribute to *A. gigas* conservation.
- Assist with the diversification of productive activities and living conditions of the Peruvian Amazon inhabitants.

The program anticipates the following results:

- Provide six *A. gigas* juveniles to each of 93 small-scale producers (currently 31 producers received six juveniles each) along the Iquitos-Nauta Road, as an initial phase of the program.
- Incorporate *A. gigas* culture as a productive activity in the Amazon region.
- Create awareness among the Amazon inhabitants in general (e.g., fish producers, fishermen) in the practice of *A. gigas* cultivation.
- Increase the diversity of *A. gigas* products offered.
- Decrease *A. gigas* fishing pressure in its natural habitats.
- Develop a broodstock batch managed by the small-scale producers to increase fingerling supply.

Activities and Methodology

Breeding A. gigas juveniles

The *A. gigas* juveniles (25 cm average total length) are coming from the natural reproduction of pond-raised broodstock held in IIAP Quistacocha and Pucallpa facilities, Peru.

Identification of Beneficiaries

The beneficiaries of the program were identified based on the following criteria: 1) Readiness and suitability of their pond(s); 2) Degree to which *A. gigas* broodstock security could be

continued on p. 16...

ARAPAIMA Culture Program Collaborators

~ Iquitos, Loreto ~

Fernando Alcántara, Palmira Padilla, Rosa Ismiño, and CRSP extensionists Luciano Rodríguez and Carlos Chávez

~ Pucallpa, Ucayali ~

Mariano Rebaza, Carmela Rebaza, and Sonia Deza

~ Tarapoto, San Martin ~

Humberto Guerra, Gilberto Ascón, and Jorge Iberico

~ Southern Illinois University Carbondale ~

Christopher C. Kohler, Susan T. Kohler, and William Camargo

Comparison of Tilapia and *Clarias*

...from p. 12

there were no significant differences ($p>0.05$) in survival rate and stocking size of fish among treatments.

Relative profitability analysis using partial and full enterprise budgets revealed that PFP was the best feed followed by RB at normal selling price of Kshs 90 kg^{-1} fish. At higher prices of Kshs 120 kg^{-1} and if price varies by size in favour of bigger fish PFP would still be a better choice followed by TDP while RB would be least profitable. RB and PFP had significantly lower ($P<0.05$) break-even prices on total cost than TDP. RB recorded least operational cost.

This study assessed relative profitability of the three nutrient regimes and gave full enterprise budget for the most profitable one. It should therefore be a valuable contribution to development of management practices involving nutritionally incomplete feeds. In addition, the development of cost-effective tilapia feed may increase the profitability of fish farming in the region and stimulate commercial aquaculture enterprises.

Mollusks in Amazonia

...from p. 11

medium (5,000 m^{-2}), and high (10,000 m^{-2}) stocking densities, respectively. Thus, the culture and processing of churo offers excellent potential to produce animal protein at a very low production cost.

Other potential candidates that deserve research effort are the Amazonian soft-shell clams (*Anodontites* spp.) locally named *tumba-cuchara*, which possess very fast growth of visceral mass compared to the shell, which is surprisingly very thin (Fig. 3). This bivalve has been reported to grow up to 10 cm in less than seven months in fishponds (stocked with paiche–*Arapaima gigas*) at high densities at IIAP, Pucallpa (M. Rebaza, personal communication), Lago de Sauce, Tarapoto (Campos, personal communication), and other localities of the Peruvian Amazon. The natural habitat of these bivalves is also very diverse. They are present in white (high silt) and black (high tannin) waters, in meanders, and in waters with considerable flow rates. The soft-shell clams have been reported in the Amazon, Itaya, and Tapiche Rivers, near Iquitos, and are probably widely distributed throughout the entire Amazon region. Surprisingly, they are rarely present in the largest local markets (Iquitos and Manaus, Brazil), and little information is available regarding their consumption by the riverside people. Some regional Peruvian dishes, however, incorporate this bivalve in diverse combinations such as cebiche (marinated clams and/or fish), picante (hot sauce) with rice, and picante with yucca. Accordingly, this resource could become another important alternative to diversify aquaculture in a resources-rich region where, unfortunately, some inhabitants are malnourished (Amazon Alliance, 2000) because of lack of knowledge of all the alternatives available.

WILLIAM CAMARGO

Half-grown bivalve locally named "tumba-cuchara," Anodontites *sp. (13.4 mm length, and 8 months old), found in a recently drained fish culture pond at IIAP Pucallpa.*

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Feed Conversion Efficiency

...from p. 13

prices ($215/metric ton and $60/1000, respectively), feed plus fingerling costs (others factors held constant) per metric ton of net fish yield is lowest if fish are harvested at a weight of 1000 g. If fingerling prices remain at current rates ($60/1000) but feed prices increased by 85% to $401/metric ton, the smaller weight class of catfish (250–500 g) became the economically superior size class due to the least cost of input requirement to obtain a net fish yield of one ton. When feed prices held at current rates but fingerling prices raised, the next larger size class (1000-1500 g) became economically superior only after fingerling prices are increased by 133% to $140/1000.

Arapaima Pond Culture

...from p. 14

guaranteed; and 3) Interest of the producer to conduct *A. gigas* cultivation.

Forage fish (prey) culture and A. gigas stocking

The small-scale producer ponds are fertilized and initially stocked a few weeks before stocking with *A. gigas* juveniles, with bujurqui (*Cichlasoma amazonarum*) and/or mojarra (*Gymnocorymbus thayeri* and *Tetragonopterus* sp.) at stocking densities from 20,000 to 30,000 fish/pond, to secure a forage base.

Monitoring

The monitoring of the performance of the *A. gigas* is conducted by two CRSP extensionists who carry out periodic visits to the *A. gigas* producers to monitor growth, sanitary state, survival, and yield (kg ha^{-1} yr^{-1}). The monitoring will be conducted for a year, and the data will be collected and analyzed to determine *A. gigas* performance in culture ponds.

PEDRO ICOMEDES

Jaime Boria, a beneficiary (center), expressing appreciation for one of the six Arapaima *juveniles provided to him by the IIAP-CRSP.*

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Notice of Publication

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CRSP Research Report 02-185

Recycling pond mud nutrients in integrated lotus–fish culture

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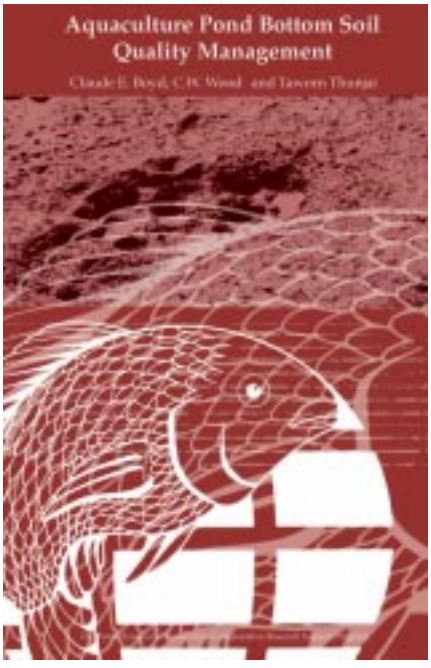
An experiment was conducted in nine 200-m^2 fertilized earthen ponds at the Asian Institute of Technology, Thailand, during January–September 2000. This experiment was designed to assess the recovery of nutrients from pond mud by lotus (*Nelumbo nucifera*), to assess pond mud characteristics after lotus–fish co-culture, and to compare fish growth with and without lotus integration. There were three treatments in triplicate: (A) lotus–tilapia co-culture; (B) tilapia alone; (C) lotus alone. Seedlings (0.39 ± 0.09 kg) of Thai lotus variety were transplanted to ponds of the treatments with lotus (treatments A and C) at a density of 25 seedlings $pond^{-1}$, while sex-reversed all-male Nile tilapia (*Oreochromis niloticus*) fingerlings (8.6–10.3 g) were stocked at two fish per square meter in ponds of the treatments with tilapia (treatments A and B) when the water depth had been increased to 50 cm due to increasing lotus height. Ponds stocked with tilapia (treatments A and B) were fertilized weekly with urea and triple super phosphate (TSP) at a rate of 4 kg nitrogen (N) and 1 kg phosphorus (P)/ha/day after tilapia stocking. There was no fertilization in ponds of the lotus alone treatment. Lotus co-cultured with tilapia or cultured alone in ponds was able to effectively remove nutrients from old pond mud. Annual nutrient losses from mud in a 1-ha pond was about 2.4 ton N, and 1 ton P, among which about 300 kg N and 43 kg P were incorporated in lotus biomass. There were no significant differences in lotus growth performance between the lotus–tilapia and lotus alone treatments, while Nile tilapia cultured alone grew significantly better than when co-cultured with lotus. The present experiment has demonstrated the effectiveness of nutrient removal from old pond mud by lotus and the feasibility of rotation and co-culture of lotus and Nile tilapia. Both systems can recycle nutrients effectively within ponds and are environmentally friendly culture systems.

This abstract was based on the original paper, which was published in *Aquaculture*, 212 (2002):213–226.

PD/A CRSP Publishes Pond Soil Manual



Congratulations are due to Dr. Claude E. Boyd and his co-authors, C.W. Wood and Taworn Thunjai, for the successful completion of their manual, *Aquaculture Pond Bottom Soil Quality Management*, published in July 2002 by the PD/A CRSP, Corvallis.

The 41-page manual offers a succinct yet comprehensive guide to all aspects of managing pond soils, from initial excavation to ongoing care of soils in mature pond systems. An introduction to chemical and physical soil characteristics is followed by practical details on pond soil treatments. Traditional methods such as liming and tilling are covered, while more modern approaches such as disinfection are also included. The book's final section on soil analysis provides technicians straightforward practical methods to sampling soils and to analysis for pH and lime requirements.

This book will prove invaluable to managers of aquaculture facilities where earthen ponds are used. Students and researchers will also benefit by gaining useful insights into methods for maintaining productive pond systems.

Request copies by email from harrirog@onid.orst.edu or from:
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PD/A CRSP Hosts Delegation From China

by Roger Harris

China's aquaculture tradition stretches back two thousand years or more. Yet the Chinese feel they have much to learn from the rapid developments in aquaculture technology in other parts of the world.

As part of a US Department of Agriculture-sponsored fact-finding mission to the US, seven delegates from the People's Republic of China were hosted by the PD/A CRSP at Oregon State University, 30-31 October 2002.

The group began at the Environmental Protection Agency facility on the OSU campus. Discussions focused on the legal and environmental aspects of aquaculture, especially with regard to the regulation of potentially hazardous chemicals such as fungicides and masculinizing hormones.

During a tour of the OSU Food Toxicology Nutrition Laboratory, Dr. Dave Williams, Director, explained how intensive culture of rainbow trout was providing material for investigation of environmental carcinogens.

Nearby is the Salmon Disease Laboratory where Rob Chitwood described pathogens affecting hatchery-raised fish in Oregon. The delegates showed a keen interest in novel technologies to apply antibiotics through medicated feed. The group was also fascinated with the sturgeon being raised at the laboratory for research into caviar production.

After lunch, the group met on the OSU campus with Dr. Hillary Egna, Director of the PD/A CRSP, and also with Dr. John Bolte, Interim Dean of OSUs Bioengineering Department. Dr. Bolte developed the POND© software package, designed to facilitate decision-making by aquaculturists. Mr. Zeng Hui, Vice Director of Guangxi Fishery Research Institute, had previously corresponded with Dr. Bolte on the prospects of converting the software to a Chinese language interface. Dr. Egna helped facilitate an agreement for the Guangxi Fishery Research Institute to begin the process of converting the software, and OSUs Bioengineering Department to train a student from China in the C++ programming language needed to compile the program.

ROGER HARRIS

At the OSU Food Toxicology Nutrition Laboratory, Dr. Dave Williams (Director NIEHS Marine/Freshwater Biomedical Sciences Center), explains aspects of the laboratory's operations. (Pictured: Li Xiaozheng, Chen Hong, Huang Zhen, Wan Xun, Xiong Fengming, Zeng Hui, Wang Guoli, Dave Williams.)

In the Political Science Department the group met with Professor Bill Lunch, Head of Department and well-known commentator. Also present were Professor Pat Corcoran, Professor Brent Steel, and Assistant Professor Hua-yu Li, who is also Chinese. Professor Lunch replied to numerous questions from the visitors, including a technical but illuminating discussion on the USs stricter limits for contaminants in fish food products from China compared to western countries.

The final visit of the day was back at the Salmon Disease Laboratory where the group met with Professor Michael Kent. Dr. Kent enjoyed showing the group the facilities for pathological work on fish, including the well-equipped histology lab.

The PD/A CRSP then hosted the group for a second day, this time to visit various locales in Newport on the Oregon coast.

First stop was the Oregon Oyster Farm, where owner and manager Liu Xin introduced the group to the practical and economic aspects of oyster farming. The group savored the local product raw, with a fiery hot sauce.

Next was a visit to the Oregon Coast Aquarium, renowned for its displays of marine life.

At Hatfield Marine Science Center (HMSC), the group met with Carol Delancy of the Marine Mammal Program who spoke on current research issues. Dr. Chris Langdon, a professor in OSUs Fisheries and Wildlife Department and a Principal Investigator for the CRSPs OSU Kenya project, discussed the Center's Molluscan Broodstock Program. Next, the group sampled dulse (*Palmaria palmata*), a rhodophyta (seaweed) that is cultured as abalone food. They were then shown the clownfish broodstock system that is being used to test microparticulate diets.

With the increasing pressure on global food resources and the potential of aquaculture to meet the demand, such cultural exchanges will become ever more valuable. Effective communication between aquaculture practitioners and experts from widely varying backgrounds is essential to ensuring that technological advances remain focused on providing the most efficient means of raising fish

Upcoming Conferences and Expositions

Date	Topic/Title	Event Location	Contact Information
November 28–December 1, 2002	Feria de la Pesca 2002	Montevideo, Uruguay	Gloria Scelza; Centro de Informacion Tecnica, Infopesca, Uruguay; Fax: 598-2-903-0501; Email: pesca2002@latu.org.uy; Website: <www.latu.org.uy>
December 10–14, 2002	Symposium On Intensive Use Of Groundwater	Valencia Conference Center, Valencia, Spain	Margarida Valverde; Phone: 34-934-582-600; Fax: 34-964-590-106; Email: gerencia@fcihs.org; Website: <www.fcihs.org/SINEX.HTM>
December 17–20, 2002	Sixth Indian Fisheries Forum	Mumbai, India	S. Ayyappan; Convenor, Sixth Indian Fisheries Forum, Central Institute of Fisheries Education, India; Phone: 91-22-636-1446/7/8; Fax: 91-22-636-1573
February 18–21, 2003	Aquaculture America 2003	International Convention Center, Louisville, Kentucky	Conference Manager; 2423 Fallbrook Place, Escondido, CA 92027; Fax: 760-432-4275; Email: worldaqua@aol.com; Website: <www.was.org>
February 20–22, 2003	Asian Fisheries, Aquaculture and Seafood	Bangkok, Thailand	Baird Publications, Australia; Fax: 61-3-9645-0475; Email: marinfo@baird.com.au; Website: <www.baird.com.au>
March 19–22, 2003	AquaSur 2003	Club de Deportes Nauticos Reloncavi	Sue Hill; Heighway Events, England; Fax: 44-0-20-7017-4537; Email: sue.hill@informa.com; Website: <www.heighwayevents.com>
April 20–23, 2003	Middle East Aquaculture and Fishing Show 2003	UAE, Dubai	Abdulla A. Abulhoul; Mediac, Dubai, UAE; Fax: 9714-2691296; Email: mediac@emirates.net.ae
May 19–23, 2003	World Aquaculture 2003	Salvado, Brazil	Conference Manager; 2423 Fallbrook Place, Escondido, CA 92027; Phone: 760-432-4270 Fax: 760-432-4275; Email: worldaqua@aol.com

Workshops and Short Courses

Date	Title/Topic/Site	Contacts
November 29–30, 2002	Epidemiology and Risk Assessment/Gold Coast International Hotel, Australia	Chris Baldock; Phone: 61-7-3255-1712; Email: chris@ausvet.com.au
November 29–30, 2002	Epidemiology-Biosecurity Workshop/Gold Coast, Australia	Rochelle Manderson; Email: daa5@ozaccom.com.au
December 2–6, 2002	Asia-Pacific Regional Molluscan Health Management Training Program Phase II/Gold Coast International Hotel, Australia	Rob Allard; Phone: 61-7-3840-7723
December 3, 2002	Basic Principles of Aquaculture/Iloilo, Philippines	L. Torres Jr.; SEAFDEC Aquaculture Department, Phone: 63-33-336-2937; Fax: 63-33-336-2891; Email: pltorres@aqd.seafdec.org.ph; Website: <www.aqd.seafdec.org.ph/4647.html>
January 26–31, 2003	Practical Course On Feed/Texas A&M University, College Station, Texas	Mian N Riaz; Food and Protein R&D Center; Fax: 979-458-0019; Email: mnriaz@tamu.edu; Website: <www.tamu.edu/extrusion>
January 26–31, 2003	Feeds & Pet Food Extrusion/Texas A&M University, College Station, Texas	Mian N. Riaz; Email: mnriaz@tamu.edu Website: <www.tamu.edu/extrusion>
February 19–21, 2003	Speaking for the Salmon workshop/Vancouver, BC	The World Summit on Salmon; Website: <www.sfu.ca/cstudies/science/salmon.htm>
April 23–29, 2003	14th International Pectinid Workshop/St. Petersburg, Florida	Beth Miller-Tipton; Email: bmiller-tipton@mail.ifas.ufl.edu

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CRSP publications can be accessed electronically at <pdacrsp.orst.edu/pubs/publications.html>; print copies can be ordered online, by sending an email to <courteri@onid.orst.edu>, or by writing to:

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AQUANEWS

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