

AQUACULTURE CRSP
TENTH WORK PLAN EXTERNAL ADVISORY PANEL REPORT (2001–2003)

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Overview

In 2001, the External Evaluation Panel (EEP) submitted a report following a comprehensive 5-year review of the Aquaculture CRSP. This review process was very valuable and the Aquaculture CRSP has decided to conduct comparable subsequent external reviews at the end of each work plan, beginning here with the Tenth Work Plan (2001-2003).

This report represents the first submitted by the External Advisory Panel (EAP). The EAP is the advisory body during the transitional year for the Aquaculture CRSP when the USAID sub-sector review and program renewal were under advisement. The EAP combines members from the former internal Board of Directors and external EEP.

External Advisory Panel reports are completed by at least one member of the EAP. This individual is expected to travel to meet in person with participants of the Aquaculture CRSP, participate in Program and Technical Committee meetings, and attend presentations offered by Aquaculture CRSP participants at professional conferences to fully evaluate activities over the specific Work Plan. This Tenth Work Plan EAP report provides a review of activities conducted within the Tenth Work Plan. Program and Technical Committee meetings were convened in conjunction with the World Aquaculture Society annual conference in Hawaii, USA in March 2004. Reviewed activities also include some new projects approved for the Eleventh Work Plan but were in process of being initiated when the evaluation took place.

Tenth Work Plan External Advisory Panel Report (2001-2003)

I was impressed with the level of collaboration, general respect and camaraderie between the US PIs and the HC people. All the US PIs that I spoke to were really interested in and enjoyed the work they were doing in developing countries, and appeared very committed to making the projects successful. The HC scientists also were very keen to do good research and develop aquaculture in their countries.

The round table general discussion between the different regional groups on the Friday afternoon appeared to be a very worthwhile exercise. The Latin American group in particular were discussing regional issues, means of collaboration and communication etc. Similarly, the African group. The Asians probably had the least benefit from this session, primarily because the people from Vietnam and Bangladesh were not present. As a consequence, I was pleased to see the motion passed for regional meetings in alternate years with full program meeting to be held every two years. I think that this could be very beneficial for the countries involved. However, I suspect that the PMO and/or designated US PIs will need to take a fairly strong role in organising these meeting and ensuring that the country representatives get together to communicate their research and discuss regional issues.

I have previously mentioned that it could be very beneficial for HC investigators to visit other regions where similar research is being conducted to develop low technology aquaculture suitable for developing countries. A specific example is for the Kenyans working on Tilapia pond culture to visit AIT to experience the extensive research that they have conducted on developing low tech, low cost culture methods. This came up in conversation after the annual meeting and I urged the two groups into making at least a tentative commitment. Thus Charles Ngugi is proposing to visit Yang Yi at AIT for ~ 2 weeks after WAS in Bali, Indonesia.

I think such collaborations could be very productive and provide a contrast to the HC PIs always seeing the high tech, intensive culture methods used in the USA. In the developing countries there is a much stronger emphasis on feeding the masses as well as developing cottage industries, compared with the sophisticated marketing systems in the USA. A follow on suggestion is to consider holding some annual and regional meetings at HC institutions, recognising that some locations would be much easier than others and costs could blow out. However, advantages would be the HC showing off their research and stimulating discussions specific to their research projects. On the other hand there are definitely benefits of getting scientists from developing countries to international conferences, although WAS is getting so large now with some 15 concurrent sessions that I wonder whether a smaller, more specific conference might be better value.

Re the white papers, I think most of the participants saw these papers as a discussion of issues and potential areas of research for the CRSP rather than preparing policy on particular issues. This came through especially with the paper on indigenous species with some people appearing to see this as a threat to continuing work on introduced species such as Tilapia, which I assume was not the intention. You may need to clarify whether these are white papers for policy and if so, then ensure that all important areas of research are covered. In developing countries culture of already domesticated species such as Tilapia to provide protein to a large population is very important and should not be undermined at this stage by the culture of indigenous species, which other than rare

exceptions, will take many years to progress to a semi-commercial level. I agree that policy on issues such as GMOs, would be good. It may also be useful to assess various administrative requirements between institutions to verify that they are reasonably consistent and workable across the CRSP, e.g. ethics, intellectual property, publication procedures etc. I would also like to suggest a policy on introductions and translocations because I have concerns about the distribution of species around the globe that is still occurring under the guise of development with little thought to the environment.

I didn't get enough detailed information on most projects to be able to comment on how they are progressing or to identify potential CRSP success/impact stories. On the other hand, I didn't hear of, nor get the impression, that any projects are experiencing major problems, other than the insecurity over continuation of funds, and I'm sure that you are aware of this. Funding definitely came across as the biggest issue by far for everyone.

Of the project presentations, OSU Mexico's stood out as providing the type of information that you are likely to require to support the continuation of the CRSP, and hence the projects which would be easiest to promote CRSP success. I thought that this report was very good. By contrast the report given by the new Mexico Project group was not easy to understand and I found it difficult to pinpoint what they are proposing to do.

It is interesting to note that in the 3+ years that I have been involved with the Aquaculture CRSP the emphasis appears to be changing from aquaculture food production projects towards environmental issues, especially with the watershed management and health, welfare and human nutrition projects. Presumably this will fit well with the CRSP now being in the Environment program, although of course I am not familiar with the politics behind all of this. Even though I currently work more in the environment than aquaculture development area myself and so obviously recognise the importance of environmental management, some projects, e.g. the new project from Mexico, appear to be more concerned with environmental protection than aquaculture. As this is an Aquaculture CRSP shouldn't the emphasis be on sustainable development and production, such as development of Best management Practices/Environmental Management Systems that take into account the environmental effects of aquaculture both locally and at a regional/watershed scale or determination of the assimilative capacity of a region for aquaculture activities (i.e. maximum sustainable production without detrimental impact on the environment)?

Overall I was impressed with the CRSP: the work being conducted and the enthusiasm from the researchers, and of course the PMO that makes this all happen. Well done.

Christine Crawford, March 2004 (report date)

Aquaculture CRSP Tenth Work Plan Investigations

1 AUGUST 2001–31 JULY 2003

| RESEARCH AREA: PRODUCTION OPTIMIZATION | | |
|--|------------------|---|
| Research Theme | Reporting PI | Investigation Title |
| Pond Dynamics | Boyd | Effects of Pond Age on Bottom Soil Quality |
| | Batterson | Workshops on Using Principles of Pond Dynamics to Optimize Fertilization Efficiency |
| | Bowman | Aquaculture Training for Kenyan Fisheries Officers and University Students |
| Feeds and Fertilizers | Kohler | Nutrition of <i>Colossoma macropomum</i> and <i>Piaractus brachypomus</i> |
| | Dabrowski | Broodstock Diets and Spawning of <i>Colossoma macropomum</i> and/or <i>Piaractus brachypomus</i> |
| | Lochmann | Broodstock Diets and Spawning of <i>Colossoma macropomum</i> and/or <i>Piaractus brachypomus</i> |
| | Diana | Polyculture of Grass Carp and Nile Tilapia with Napier Grass as the Sole Nutrient Input in the Subtropical Climate of Nepal |
| | Lim | Development of Economically Feasible Feeds for Semi-Intensive Culture of Tilapia, <i>Oreochromis niloticus</i> , Using Locally Available Agricultural By-Products |
| Reproduction Control | Dabrowski | Studies on Fate of Methyltestosterone and Its Metabolites in Tilapia and on the Use of Phytochemicals as an Alternative Method to Produce a Monosex Population of Tilapia |
| | Schreck | Selection of a New Nile Tilapia Genetic Line to Provide Broodstock for Southeastern Mexico |
| | Brown | IGF as a Growth Rate Indicator in <i>Oreochromis niloticus</i> |
| Aquaculture Systems Modeling | Diana | Development of a Trophic Box Model to Assess Potential of Ecologically Sound Management for Cove Aquaculture Systems in Tri An Reservoir, Vietnam |
| New Aquaculture Systems/ New Species | Kohler | Amazon Aquaculture Outreach |
| | Kohler/Dabrowski | Studies on Reproduction and Larval Rearing of Amazonian Fish |
| | Fitzsimmons | Stocking Densities for Tilapia-Shrimp Polyculture in Thailand |
| | Fitzsimmons | Survey of Tilapia-Shrimp Polyculture in Mexico |
| | Fitzsimmons | Survey of Tilapia-Shrimp Polyculture in Vietnam and Thailand |
| | Fitzsimmons | Stocking Densities for Tilapia-Shrimp Polyculture in Mexico |
| | Fitzsimmons | Survey of Tilapia-Shrimp Polyculture in the Philippines |
| | Phelps | Evaluation of Growth and Reproductive Performance of Three Strains of Nile Tilapia <i>Oreochromis niloticus</i> Found in Kenya for Use in Aquaculture |
| | Bowman | Techniques for the Production of <i>Clarias gariepinus</i> Fingerlings as Baitfish for the Lake Victoria Nile Perch Longline Fishery |

| RESEARCH AREA: ENVIRONMENTAL EFFECTS | | |
|---|---------------------|---|
| Research Theme | Reporting PI | Investigation Title |
| Effluents and Pollution | Boyd | Reaction of Liming Materials in Pond Bottom Soil – South Africa |
| | Boyd | Reaction of Liming Materials in Pond Bottom Soils – Brazil |
| | Schreck | Elimination of Methyltestosterone (MT) from Intensive Masculinization Systems: Use of Activated Charcoal in Concrete Tanks |
| | Diana | Environmental Impacts of Cage Culture for Catfish in Hongngu, Vietnam |
| Appropriate Technology | Verma | Regionalizing Training and Technical Assistance for Nongovernmental Organizations |
| | Verma | Institutionalizing Web-based Information System for Tilapia Culture in Latin America |
| | Schreck | Diversification of Aquacultural Practices by Incorporation of Native Species and Implementation of Alternative Sex Inversion Techniques |
| | Diana | On-Station and On-Farm Trials of Different Fertilization Regimes Used in Bangladesh |
| | Batterson | Use of Clinoptilolite Zeolites for Ammonia-N Transfer and Retention in Integrated Aquaculture Systems and for Improving Pond Water Quality before Discharge |
| GIS: Planning, Policy, and Global Data Analysis | Diana | A Study of Aquaculture Brownfields: Abandoned and Converted Shrimp Ponds in Thailand |
| | Diana | Assessing Watershed Ponds for Aquaculture Development in Thai Nguyen, Vietnam |
| | Clair | Identification of Constraints Facing Aquaculture in the Next Two Decades and Formulation of a Five-Year Research Agenda to Address Key Constraints Through Collaborative Research |
| RESEARCH AREA: SOCIAL AND ECONOMIC ASPECTS | | |
| Research Theme | Reporting PI | Investigation Title |
| Marketing & Economic Analysis | Engle | Optimal (Profit-Maximizing) Target Markets for Small- and Medium-Scale Tilapia Farmers in Honduras and Nicaragua |
| | Engle | Development and Evaluation of a Simple Market Feasibility Assessment Methodology |
| | Engle | Regional Enterprise Budget and Business Plan Development |
| | Engle | Economic and Risk Analysis of Tilapia Production in Kenya |
| Adoption/ Diffusion | Bowman | Aquaculture Training for Kenyan Fisheries Officers and University Students, II |
| | Verma | Institutionalizing Techniques for Building Hillside and Levee Ponds for Water Supply and Aquacultural Development in Latin America |
| Food Security | Molnar | Income, Food Security, and Poverty Reduction: Case Studies of Functioning Clusters of Successful Small-Scale Aquaculture Producers |
| Decision Support Sys | Diana | PD/A CRSP Database: Finalization, Management, and Distribution |

| | | |
|-----------------|-------|---|
| Product | Engle | Characteristics of Fish Buyers Likely to Purchase Farm-Raised Tilapia in Honduras and Nicaragua |
| Diversification | Brown | Cost Containment Options for Tilapia Production in Central Luzon, Republic of the Philippines |
| | Diana | Transfer of Production Technology to Nepal for Nile Tilapia, <i>Oreochromis niloticus</i> |

Aquaculture CRSP Research Presentations

Presentations covered research conducted within the Tenth Work Plan

2004 World Aquaculture Society Meeting

1-5 MARCH 2004

HONOLULU, HAWAII

(PRINTED AS RETRIEVED FROM THE WORLD AQUACULTURE SOCIETY)

WATER QUALITY ISSUES IN SHRIMP FARMING

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Water quality in shrimp aquaculture ponds is managed much better than it was 20 years ago, but there is still much opportunity for improvement. A major advance is the use of mechanical aeration to improve water quality and allow greater production. Nevertheless, there is need for research, especially in Asia, to enhance the efficiency of aeration equipment. Liming also has resulted in great improvements in water quality in areas with acidic soils, but shrimp farmers still have little knowledge of the properties and proper use of liming materials. Liming materials frequently are applied unnecessarily or misused in other ways. The widespread application of probiotics, both bacterial inocula and enzyme preparations, is not supported by research findings showing these products to be effective. Moreover, zeolite is still commonly applied to shrimp ponds in Asia to remove ammonia and hydrogen sulfide, but there is no scientific basis for this practice. The application of silicate fertilizer to enhance diatom production often is done without regard to natural silicate concentrations in pond waters or other evidence that silicate concentration is low. Better feeding practices and less water exchange has reduced the quantity and possibly improved the quality of shrimp farm effluents. However, few shrimp farms monitor effluents, and the amounts of nutrients released from shrimp farms seldom are known. In response to environmental concerns, there has been much discussion of best management practices (BMPs) to prevent negative environmental impacts. If producers will adopt these practices, great strides can be made in improving shrimp farm management procedures, reducing negative environmental impacts, and enhancing the sustainability of shrimp aquaculture. Consumers are becoming more environmentally aware and more conscious about food safety. Thus, there is a growing demand for shrimp certified to have been produced by responsible management.

QUALITY OF LIMING MATERIALS USED IN SHRIMP FARMING IN THAILAND

□

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Samples of 45 brands of liming materials used in shrimp farming in Thailand were analyzed for chemical and physical properties. Eight of ten products sold as ground calcium carbonate (calcitic agricultural limestone) were properly identified by vendors and of high quality, i.e., neutralizing value and fineness rating above 85%. Seven of fifteen products sold as ground dolomite (dolomitic agricultural limestone) were properly identified, seven were ordinary pulverized limestone instead of dolomite, and one was lime. The seven dolomitic agricultural limestone samples were of high quality, i.e., fineness rating above 85% and neutralizing value above 95%. Only two of eight misidentified samples were of high quality. Only one of four products sold as marl had neutralizing value and efficiency rating above 85%, but all were properly identified. Five products sold as crushed seashell had been burned and should have been identified as lime. However, the neutralizing value of these products ranged from 72 to 103% and was lower than those of good quality lime. All thirteen samples sold as lime were properly identified, and eight were of good quality, i.e., neutralizing value above 120% and fineness rating above 85%. The cost of liming materials ranged from \$0.01 to 0.20/kg for marl to \$0.10 to 0.14/kg for lime. There was no relationship between product quality and cost. Shrimp farmers in Thailand should insist that manufacturers and vendors of liming materials provide data on product composition.

METHODS FOR LESSENING WATER USE IN AQUACULTURE

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Water obviously is of paramount importance for aquaculture, and water conservation is an essential ingredient of sustainable, freshwater aquaculture. Many aquaculture systems do not increase consumptive water use greatly, and these systems can be more efficient in water use than traditional agriculture. Nevertheless, more attention should be given to increasing the efficiency of water use in aquaculture for the purposes of conserving water, decreasing the cost of supplying water to culture systems, and minimizing the volume of effluents. Two indices of water use efficiency are suggested: (1) a total water use index calculated as kilograms of production per cubic meter of water used; (2) a consumptive water use index calculated as kilograms of production per cubic meter of water consumed. Consumptive water use should be calculated as the sum of water contained in harvested biomass, evaporation and seepage losses, and water removed from underground aquifers. Economic indices of water use also can be obtained by calculating the value of production per cubic meter of total water use or consumptive water use. The efficiency of water use may be increased by production methods that increase the intensity of production, but this will increase the inputs of other resources. Production methods that permit harvest without draining ponds and rain fed aquaculture systems use water efficiently and are readily adaptable to low-input aquaculture schemes. Although cage culture in natural waters or flow-through aquaculture units consume very little water, they have a high potential for impairing water for other uses. Nevertheless, these production systems could be integrated into irrigation schemes to allow excessive nutrients from aquaculture to be applied to agricultural crops.

MARKETING OF CULTURED FISH BY SMALL-SCALE PRODUCERS IN THE PERUVIAN AMAZON

□

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Small-scale farmers in the Peruvian Amazon are culturing fish for their family's nourishment as well as to obtain an additional source of income by selling their products in the markets of Iquitos, the largest population center in the region. Fish species of primary interest for culture are gamitana (*Colossoma macropomum*), paco (*Piaractus brachypomus*), boquichico (*Prochilodus nigricans*) and, more recently, the omnivorous redbtail sabalo (*Brycon* sp.). Culture of the latter species has escalated due to its relatively high price, acceptance, and year-round demand in the marketplace.

In this paper we report production and sales data of fish cultured in 2002 by 27 producers along the Iquitos-Nauta Road. These data were obtained from surveys conducted during periodic visits made by two extensionists to farms and major marketing outlets. Fish are cultivated in ponds of diverse size, with feeds coming from native food sources such as pijuayo (*Bactris gassipaes*), aguaje (*Mauritia flexuosa*), guayaba (*Psidium guajava*), n (*Pentamera Belucia*), yucca roots (*Manihot sculenta*), insects (termites) and other miscellaneous food items.

Marketing of fresh whole fish is accomplished directly by the producers, and primarily takes place during the rainy season when wild-caught fish are in short supply. Redtail sabalo comprised the bulk of sales in terms of weight and gross income (Table 1). Production of redbtail sabalo is a relatively new enterprise in the Peruvian Amazon and the species is positioned to become an important culture species. However, fingerlings are coming exclusively from the wild and research is desperately needed to close the species' life cycle in captivity.

Small-scale fish culture in the Peruvian Amazon has increased substantially in the past few years as a result of efforts by several Peruvian institutions, non-governmental organizations, and collaboration with US universities through the Pond Dynamics Aquaculture Collaborative Research Support Program funded through the US Agency for International Development. As a direct consequence of these efforts, aquaculture is contributing to an increase in fish availability, and is providing an important source of animal protein and income to the rural poor.

| Production data | Redtail sabalo | Boquichico | Gamitana | Paco |
|-----------------------|----------------|------------|----------|--------|
| Number fish stocked | 13,000 | 24,000 | 28,000 | 12,000 |
| Number fish harvested | 7,100 | 12,115 | 6,931 | 2,775 |
| Weight harvested (Kg) | 8,025 | 6,265 | 4,988 | 2,000 |
| Sale price (USD/kg) | 1.70 | 1.00 | 1.40 | 1.10 |
| Sales volume (USD) | 13,642 | 6,265 | 6,983 | 2,200 |
| Market share (%) | 47 | 21 | 24 | 8 |

Table 1. Production data for the harvest and commercialization of cultured fish by 27 small-scale producers along the Iquitos-Nauta Road, Peru.

REPRODUCTIVE AND GROWTH PERFORMANCE OF THREE LINES OF NILE TILAPIA *Oreochromis niloticus* IN TABASCO, MEXICO

□

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Since 1964, Mexico has imported five species of tilapia for aquaculture purposes. However, in several regions, the quality and quantity of the fry provided has been a constantly criticised by the farmers to the hatchery managers. We initiated a selective breeding program using 220 females and 110 males selected from a batch of fish purchased from Egypt by the State government. This first batch was selected using discriminant analysis for fish that best resembled Nile tilapia. The analysis was based on length, weight, number of scales, fins, head length, mouth diameter and eye diameter. These fish were stocked in 200 m² ponds for grow-out. From the fry obtained, three selections were made: one at 60 days, a second at 120 days (at this point the fish were separated by sex) and a third at 11 months. Six hundred females and 400 males were selected based on a combination of the best length and condition factor to obtain an F1 generation. This fish were stocked in 200 m² ponds and allowed to breed. From the fry obtained, 60% of the total were selected for grow out and a second round of selections was performed to obtain the F2 generation. The performance of this line was compared against a stock of fish obtained from the wild (San Pedro River) and the line traditionally used in the State hatchery.

Table 1 shows characteristics of the females used in trials. Progeny obtained from the F2 broodstock were compared to both fry produced from a wild stock from the San Pedro River and from the San Pedro State hatchery. In general, the selected Egypt line had better reproductive performance and good survival and growth.

Wild fish from the San Pedro River grew as well as those produced by the Egypt line for 45 days; however, at the end of the growth trial, the fish from San Pedro showed a higher size than the fish from the Egypt line (figure 1).

This study was conducted as a collaborative effort between the PDA/CRSP, the National Council for Science and Technology (SIGOLFO-CONACyT) and the office for Agriculture and Fisheries Development (SEDAFOP) in Tabasco.

Table 1. Characteristics of females (n=5) from three lines of tilapia

| Characteristic | Line | | |
|------------------------|--------------|----------------|--------------|
| | San Pedro | State hatchery | Egypt |
| Mean weight (g) | 290 (± 30.2) | 238.3 (± 19.8) | 266 (± 4.9) |
| Mean length (cm) | 26.1 (± 1.5) | 24.6 (± 1.1) | 24 (± 0.5) |
| Gonadal weight (g) | 7.8 (± 1.5) | 2.4 (± 2.1) | 5.3 (± 1.1) |
| Mean fillet weight (g) | 89 (± 49.8) | 71.8 (± 12.9) | 86.9 (± 7.6) |
| Fillet yield (%) | 290 (± 30.2) | 238.3 (± 19.8) | 266 (± 4.9) |
| GSI | 3.2 | 1.0 | 2.4 |
| Condition factor | 1.6 | 1.6 | 1.9 |

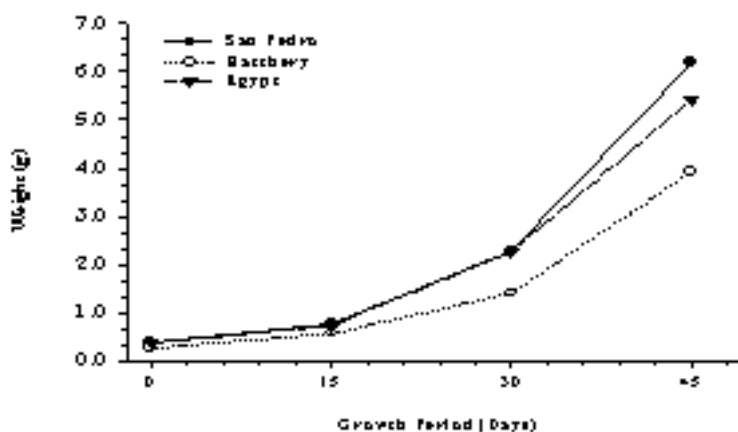


Figure 1. Growth of fry from three tilapia lines

ELIMINATION OF METHYLTESTOSTERONE FROM INTENSIVE MASCULINIZATION SYSTEMS USING ACTIVATED CHARCOAL FILTERS

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Abstract: This study tested the hypothesis that activated charcoal can eliminate 17 β -methyltestosterone (MT) from the water used in intensive sex-inversion systems. Two amounts of charcoal (2.5 and 5.0 kg) were placed in filters and a control group (no charcoal) were evaluated for both sex inversion efficacy and MT persistence in the water. Fry (2,200-2,945/m³) were treated with a masculinizing dose of MT (60 mg/kg feed) for four weeks beginning at the initiation of feeding in concrete ponds containing 7.13 m³ of

water. Water samples were collected from the sex-inversion tank before the onset of treatment and weekly beginning on the first day of treatment. Activated charcoal used in the treatment was exposed to direct sunlight for 24 or 48 hours, and samples were collected at different times for MT detection. All samples were extracted using ether and the concentration of MT determined by radioimmunoassay at Oregon State University.

MT was efficiently removed from the water using filtration. In general, MT was not detectable in the water at the end of the trials in any of the systems that had a filtration system. MT levels in water were detected at low levels at different times but the compound was never seen consistently at all sampling points within a tank. The sensitivity of the MT RIA was relatively low (10 pg/tube) and we suspect that these few low detections of MT were spurious. From all of the samples examined, MT was detected only 4.17 % of the time. MT concentrations varied between 0.14 and 9.17 ng/ml and the appearance of the largest value occurred as an isolated case. All the other values were below 1.0 ng/ml.

Masculinization rates were not significantly different ($P>0.05$) between treatments in a trial or between trials. Mean percentage of males for treatments with 0.0, 2.5 and 5.0 kg of activated charcoal were 93.8, 93.5 and 94.0 % respectively. Controls averaged 51.7% males -which was significantly less than the MT-fed groups ($P<0.001$).

Furthermore, we obtained similar results from intensive masculinization systems implemented at two tilapia farms in Tabasco, Mexico, efficiently removing MT from the water and allowing for high masculinization rates and good fry survival. These large systems showed better water quality than the systems used at UJAT, resulting in higher survival rates. Our data demonstrate that activated charcoal efficiently captures MT and that vegetal charcoal has a higher adsorption capacity than mineral charcoal. We recommend the use of activated charcoal filtration systems to eliminate excess MT and potentially increase masculinization.

FEMINIZATION OF THE TROPICAL GAR *Atractosteus tropicus* AND MASCULINIZATION OF THE CICHLID CASTARRICA *Cichlasoma urophthalmus* USING STEROID-ENRICHED ARTEMIA NAUPLII*

□

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This study evaluated if the administration of steroids via bioencapsulation is an efficient method for sex inversion of carnivorous species of fish in aquaculture. Artemia nauplii were immersed in solutions containing 2,500 mg/l of either estradiol (E2) or trenbolone acetate (TA). Steroids were dissolved in ethanol (1 mg/ml) and then added to the water. Controls were immersed in water containing ethanol vehicle only. Nauplii were thoroughly rinsed with tap water prior to administration to fish. Masculinization of castarrica fry consisted of fry fed bioencapsulated TA for 5, 10, 20, 28, 45, and 60 days. The control group consisted of fry fed Artemia nauplii immersed in a solution containing ethanol only. Gar feminization treatments consisted on fry fed with E2-enriched Artemia nauplii for (AN5, AN10, AN20, and AN28) and fry immersed in E2 solutions for 3 and 6 hours during 3 consecutive days (I3 and

I6). All treatments were triplicated. The control group was fed *Artemia nauplii* with no steroid.

Castarrica fry were effectively masculinized with TA-enriched *Artemia nauplii* when fed for more than 45 days (figure 1). In this experiment controls had 65.7% males. Feeding bioencapsulated TA for 5, 10 and 28 days did not differ statistically from the control (60.0, 51.7, and 62.3% males, respectively). Feeding TA-enriched *Artemia* for 45 and 60 days significantly increased the percentage of males (91.3 and 95.3 %; Chi square test, $P < 0.001$).

Significant feminization of tropical gar was obtained when fish were fed for 20 and 28 days with E2-enriched *Artemia nauplii* (Chi square test, $P < 0.001$; figure 5). Control groups had 21.3 % females (a condition that is similar to sex ratios we have observed in the field). When gars were fed for 20 days the percentage of females reached 51.7%, while the group fed for 28 days reached 58.0%.

*Project financed by PDA/CRSP

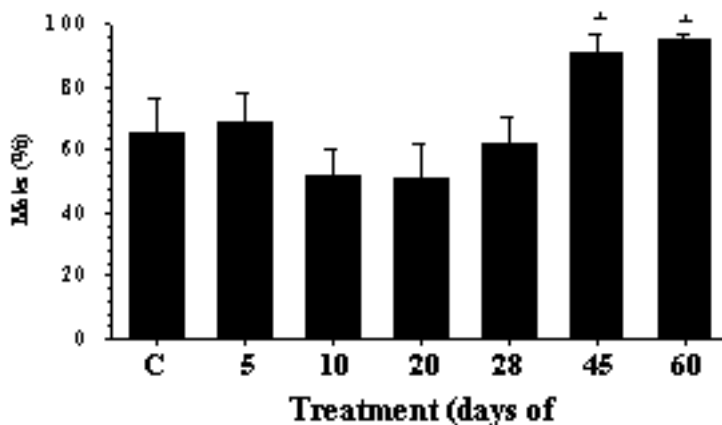


Figure 1. Masculinization of castarrica fry

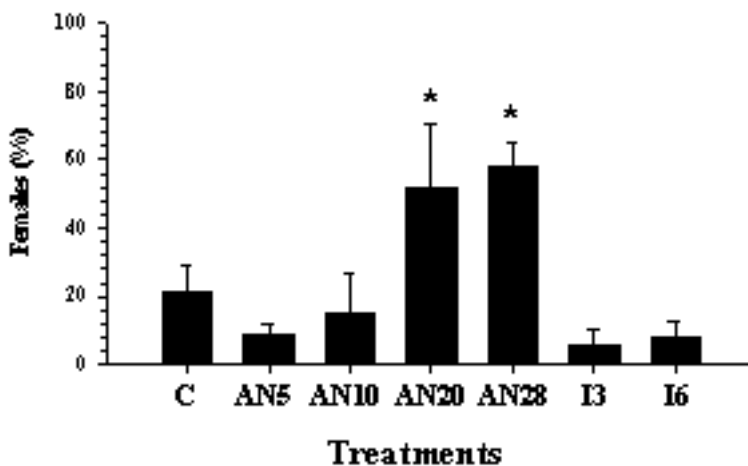


Figure 2. Feminization of tropical gar fry

USE OF STEROID-ENRICHED ARTEMIA NAUPLII FOR SEX-REVERSAL: VALIDATION OF THE TECHNIQUE USING NILE TILAPIA AS A MODEL

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This study sought to determine whether administration of steroids via bioencapsulation into live food is an efficient method for sex reversal of fish for aquacultural purposes. This technique may offer an alternative for sex reversing such species because the larvae strongly prefer live food compared to artificial diets. To determine whether steroids could accumulate in Artemia, nauplii were immersed in solutions containing 2,500 mg/l of either estradiol (E2) or trenbolone acetate (TA). Steroids were dissolved in ethanol (1 mg/ml) and then added to the water. Controls were immersed in water containing ethanol vehicle only. Each treatment consisted of three replicates. Water samples (50 ml) from glass jars containing Artemia nauplii were collected at 0, 2, 4, 6, 12, 16, 20 and 24 hours. Nauplii were washed in nanopure water, dried, and samples were frozen (-20) and preserved until processed. All samples were extracted using ether and the concentration of steroids were determined by radioimmunoassay (E2) or HPLC (TA). Immediately after addition of steroids, nauplii contained >1500 ng/g of E2 and >2000 ng/g of TA. The nauplii treated with E2 contained 5,500 ng/g at 2 hours, remained at that level until 6 hours and then reached a concentration of 7000 ng/g at 12 hours that remained until 24 hours. A similar pattern was observed when TA was used; however, at 24 hours concentrations declined to 5,000 ng/g (figure 1).

Highly significant masculinization (>95% males) was obtained when fry were fed TA-enriched nauplii for 20 days. All treatments resulted in significant masculinization (Chi square test, P <0.01). Fish fed bioencapsulated TA for 5 and 10 days had 54.7 and 80.0% males respectively. All other treatments reached more than 94% (95.3, 94.3, 99.0, and 95.7% males for 20, 28, 45, and 60 days of enriched feeding respectively). the control group had only 9.3% males (figure 2).

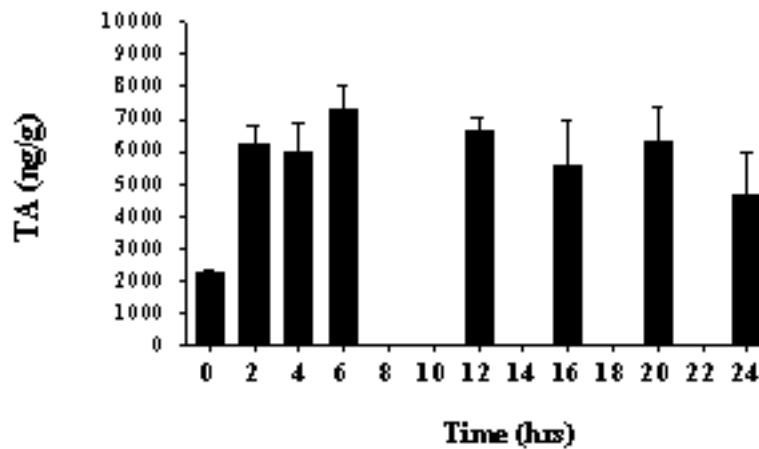


Figure 1. TA accumulation in Artemia Nauplii

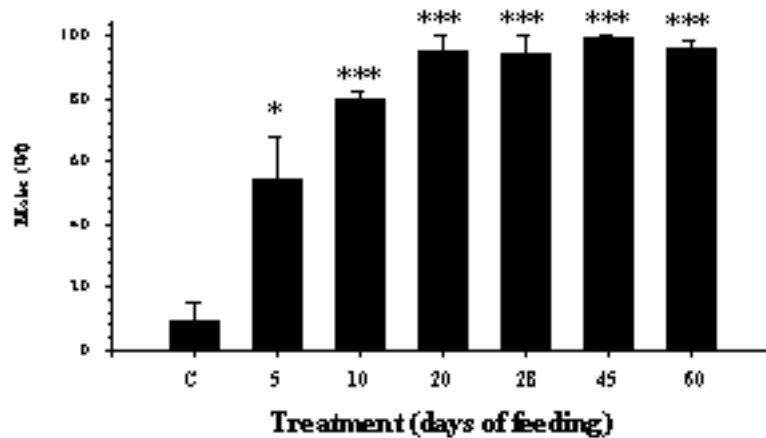


Figure 2. Masculinization of Nile tilapia using TA-enriched Artemia nauplii.

LARVAL AND JUVENILE REARING OF PACU *PIARACTUS MESOPOTAMICUS* USING LIVE FOOD AND FORMULATED DIETS

□

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The reported study aimed to investigate key aspects of nutrition and developmental biology of the Parana River system, serrasalmid fish pacu in order to improve sustainable aquaculture technology for this species. Through our collaborative effort with an Argentinean farmer (N. Gromenida, Isla Pe, S.A. Iormosa), we were able (1) to develop the procedures of first-feeding of pacu, and (2) to monitor and understand the dynamics of fish growth in intensive, high density, systems.

Larvae obtained from induced reproduction were used for the feeding experiment as 7-day old. The feeding trial was conducted in a recirculating system consisting of 24 rectangular tanks (3 tanks/dietary treatment for experiments 1 and 2, and 2 tanks for the 3rd experiment) supplied with aeration. Temperature (24–28°C) and dissolved oxygen (5–6 mg/L) were recorded on a daily basis. Ten day old larvae were randomly distributed at a density of 300 larvae/tank and 109 larvae/tank for the 2nd and for the 3rd experiment, respectively, and fed *ad libitum* ration. In the first experiment larvae were fed 5 diets: (1) live food (*Artemia nauplii*), (2) a commercial diet (French, IFREMER), (3) an experimental casein-gelatin based diet with 1% supplement of propolis, (4) an experimental diet with 15% supplement of maca meal (Dabrowski et al. 2004. J. Nutr.), and (5) an experimental diet with 16% freeze-dried beef liver. In the first experiment the larvae were fed for six days but discontinued because of limited feed acceptance. In the second experiment, diet 3 was substituted by a commercial diet (NRD, Inve, Belgium) and fed for 36 days. On day 12 of the second experiment fish fed thus far live *Artemia* were used to begin the 3rd experiment. It lasted 24 days, and fish were fed same diets (Fig. 1). Larvae at the end of each experiment (n=10) were taken from each tank and fixed in buffered formalin for biometric measurements. Performance was evaluated in terms of final individual body weight, survival (%) and specific growth rate (SGR, %).

The results of our experiments indicate that the semi-purified, casein based diets or commercial, fish meal based diets were not satisfactory for pacu as the first feed. The fish had a lower survival and lower weight gain than fed live *Artemia*. The diet supplemented with beef liver and maca resulted in a higher survival and weight gain and should be investigated further. Histological description of digestive tract development will be also presented.

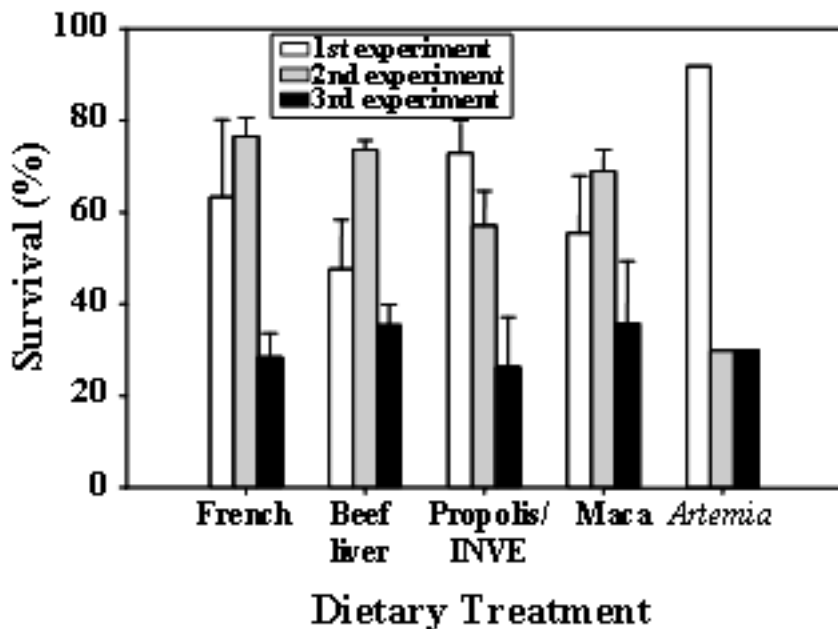


Fig. 1 Survival rates in the three experiments.

TITLE: INTEGRATED CAGE-CUM-POND AQUACULTURE SYSTEMS: A CONCEPTUAL MODEL

□

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Integrated cage-cum-pond systems refer to aquaculture where high valued species are stocked in cages suspended in ponds, and filter-feeding species are stocked in open water outside the cages. This system is designed to allow caged fish to be fed with high protein diets, while pond fish derive their nutrition from natural foods, generated by cage wastes that function as fertilizer. Such a system has many advantages, including: ability to culture fish with feed inputs under control with good water quality; use of nutrients from the pond system to produce a second fish crop; reduction in nutrients that would otherwise be discharged from intensive systems by pond assimilation; and production of a simple rotation system that allows growing some or all fish to a larger size while still rearing smaller fish extensively. The ideal integrated system would stock small fish in a pond at a given density, and their growth would be stimulated to normal levels by cage wastes. As the fish reached carrying capacity of the pond, they would

be removed, added to cages, and fed to stimulate growth to larger size, while a new stock would be introduced into the pond. Such a rotational system, done in balance, is a method to produce multiple fish crops in the same ponds while reducing nutrient input into the semi-intensive system. In Thailand we have tested a variety of combinations of cage- cum-pond integrated systems, mainly including tilapia in ponds and walking catfish or tilapia in cages. These systems have produced high yields of both pond and cage fish and with good water quality when the system is managed in balance. Examples of the system will be covered in this presentation, as well as bioenergetic tests of species combinations and comparisons of simulations with actual results. Development of such bioenergetic models will facilitate testing of other species combinations for appropriate stocking densities and cage densities.

LIPID CHARACTERISTICS OF PLASMA AND GAMETES FROM CAPTIVE PACO *Piaractus brachypomus* AND GAMITANA *Colossoma macropomum* IN PERU - CLUES TO BROODSTOCK DIET DEVELOPMENT

□

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Paco and gamitana are important food fishes in the Amazon region of Peru. Due to limited supplies of wild fishes they are cultured in captivity. However, propagation of captive stocks is unpredictable leading to inconsistent supplies of product. Nutrition may be a limiting factor in their reproductive success in captivity. Specific fatty acids such as arachidonic acid (20:4n-6), eicosapentaenoic acid (20:5n-3) and docosahexaenoic acid (22:6n-3) have been implicated in spawning success in other fish species. Tissue stores of these fatty acids can be enhanced through the diet. The relative proportions of lipid classes can be manipulated to variable extents in different tissues, but baseline data is needed before the effects of dietary manipulations can be evaluated. The purpose of this work was to characterize the lipid components of blood plasma, milt and eggs of paco and gamitana broodstock with the intent of refining diets to enhance reproduction in both species. Blood plasma was collected from males and females of both species fed either a 40%-protein diet (3 kcal DE/g protein) or a 30%-protein diet (2.6 kcal DE/g protein). Palm oil (4%) was added to both diets which contained about 8% total lipid. Total lipid of the plasma ranged from 1.5-3.0 g/100g for both species (no diet effect), but lipid was higher (P=0.09) in male paco than in female paco. Plasma sterol (ST) ranged from 5.1-5.7 g/100g for paco and 6.1-6.78 g/100g for gamitana and there was no effect of diet or gender. Plasma sterol ester (SE) ranged from 2.6-3.4 g/100g for paco and 6.2-6.4 g/100g for gamitana. SE was higher in paco fed the 40%-protein diet (P=0.09). Triglyceride (TG) was higher in male paco than in female paco (60 vs 45 g/100g, P=0.06). TG in gamitana ranged from 43.3-53.8 and was not affected by diet or gender. Phospholipid (PL) was higher in female paco than in male paco (39 vs 23 g/100g, P=0.06). PL ranged from 29.1-38.3 g/100g in gamitana and was not affected by diet or gender. Free fatty acids (FFA) were higher in paco fed the 40% protein diet (4.4 vs 2.3 g/100g, P=0.07). FFA in gamitana ranged from 2.1-3.1 g/100g and were not affected by diet or gender. Levels of 20:4n-6, 20:5n-3 and 22:6n-3 did not differ in paco or gamitana by diet or gender, but 22:5n-3 was higher in gamitana fed the 40% protein diet than in gamitana fed the 30%-protein diet.

Only qualitative comparisons of lipid data for eggs and milt from paco and gamitana combined were possible due to low sample numbers (especially from gamitana). Total lipid averaged 0.4 +0.2 g/100g in milt and 14.4 +1.8 g/100 g in eggs. The predominant lipid classes in both eggs and milt were PL, ST and monoglycerides. SE was much more prominent in milt than in eggs, and the reverse was true for ST. The ratio of n-3 to n-6 fatty acids was 1.2 +0.3 and 2.7 +1.6 for eggs and sperm, respectively. Levels of 20:5n-3 were similar in eggs and sperm. 20:5n-3 and 20:4n-6 were present in approximately equal amounts in eggs. 20:4n-6 was 4-5 times higher in sperm than in eggs, and 22:6n-3 was about 3 times higher in sperm than in eggs. 22:6n-3 was the predominant fatty acid in most sperm samples, constituting as much as 39 g/100g of total lipids.

GROWTH AND MORPHOLOGICAL CHANGES IN THE DIGESTIVE TRACT OF RAINBOW TROUT AND PACU DUE TO CASEIN PROTEIN REPLACEMENT WITH SOYBEAN PROTEIN

□

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The effect of a series of diets formulated to have one half of the protein provided from casein-gelatin replaced with extracted soybean meal (SBM) or soybean protein concentrate (SPC) in the diets of first-feeding rainbow trout (*Oncorhynchus mykiss*) or juvenile South American pacu (*Piaractus mesopotamicus*) was examined following a 3-6 fold body weight gain. The control diet was a casein-gelatin-based diet supplemented with essential amino acids, lipids (14%), and other ingredients. Rainbow trout were distributed into 35-L flow-through tanks, 50 fish per tank, triplicate groups per dietary treatment, provided with water at 14-16°C. Pacu juveniles were distributed in a similar manner, 35 fish per tank with water at 23-26°C. After 4 weeks fish were sacrificed and preserved in Bouin's fixative for further histological examinations.

Growth after 4-weeks of feeding rainbow trout was significantly depressed in both SBM- and SPC-replacement treatments (Fig. 1), whereas in pacu, later in life considered omnivorous or frugivorous fish, weight gain was significantly improved with a SBM-replacement diet. Histological examination revealed that in all the control fish and in SBM diet-fed pacu the enterocytes were correctly developed showing scarce and small lipid vacuoles. The enterocytes of both species fed the SPC diet showed numerous and large vacuoles, while enterocytes of SBM-fed trout were pathologically changed: their cytoplasm was entirely filled with lipid vacuoles of various sizes that resulted in enterocyte deformation. The highest pancreatic activity (largest number of proenzyme granules) was observed in both control groups. In both species fed SPC the pancreas was surrounded with adipose tissue and its exocrine activity was likely reduced.

The liver was correctly developed in all groups. In both control groups the number of lipid vacuoles was slightly higher compared to those fed with soybean containing diets. The results of histological analyses show that transport and metabolism of nutrients were affected by the presence of soybean in diets. We confirmed growth data differences by concluding that a SBM- diet was beneficial for pacu but adversely

affected rainbow trout, while the SPC diet inhibited nutrient absorption in both species.

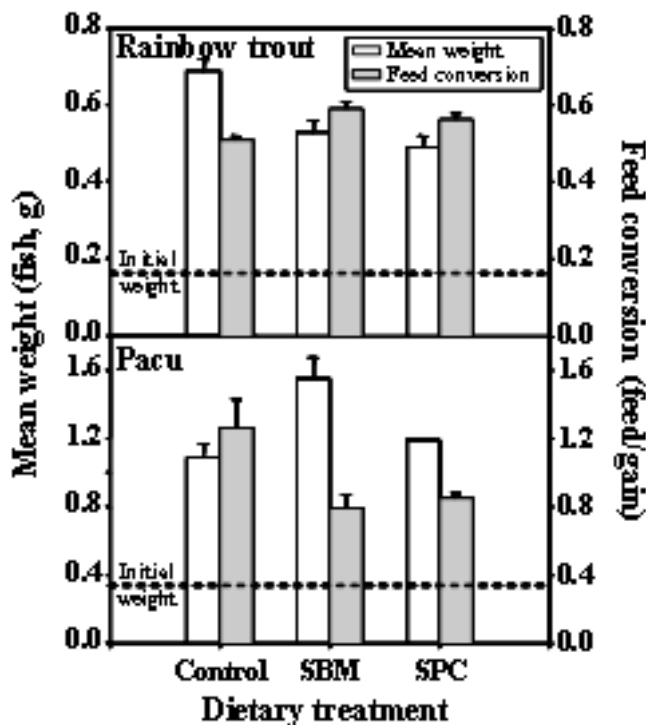


Fig. 1 Body weights and food conversion in juvenile rainbow trout and pacu following 4 weeks of diet evaluation studies.

17 β -METHYLTESTOSTERONE DETECTION IN FISH TISSUE (Tilapia) AND WATER BY A SIMPLIFIED HPLC TECHNIQUE ANALISYS

□

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17 β -methyltestosterone (17 is the preferred steroid for sex reversal in tilapia to produce all-male populations. The information available in relation to the bioaccumulation of MT in tissues, and leakage to aquatic ecosystems is partly due to the specificity-accuracy of the analysis of the hormone residues by high-pressure liquid chromatography (HPLC). Among many complications reported in regard to analysis of MT and its many hydroxylated metabolites are retention times greater than 30 min followed by an additional column re-equilibration, and requiring complex eluent gradient systems that often cause significant changes in the baseline that affect resolution and detection. Such problems have focused the analysis of steroids and metabolites by multifaceted techniques based on combined detection methods such as HPLC-MS. We re-examined whether some modifications of the existing methods would be possible to enhance accuracy and reduce labor to measure MT by using an HPLC technique.

All-female tilapia larvae were fed for 8 weeks with a semi purified casein gelatin based diet, containing 60 mg/kg of 17. Water from rearing tanks and fish tissue samples were extracted by liquid-liquid extraction in diethyl ether, the organic phase was removed after snap freezing in liquid nitrogen twice, and extracts were pooled and dried using N₂ gas. For 17 tissue extraction, each fish was homogenized in distilled water. The dry extracts were reconstituted in 0.5 ml of methanol HPLC grade, vortexed for 30 seconds and filtered through a 0.45 mm disk syringe filter; 20 ml of each reconstituted sample was injected to HPLC system for analysis.

The HPLC analysis was performed using a Beckman System equipped with a UV detection module, a Peaksimple chromatography data system and software, and a reverse phase C18 column 150X4.50 mm. Two mobile phases (MB) were used, MB A water: methanol: acetonitrile: isopropanol (62:28:5:5) and MB 2 water: methanol: butanol (35:45:20), at a constant flow rate of 30%/70% MB A: MB B of 1.0 ml/min. MT concentration was recorded at 254 nm. The standard curve was calculated with a range of concentrations from 0.02 to 20 mg/ml. The detection limit established corresponds to the lowest concentration. Extraction efficiencies were estimated at 70.16 % for water samples and 55.5 % for whole body fish tissues samples (n=5), and a mean elution time was 3.9 minutes. More detailed results will be presented on 17 tissue concentration and water 17 loss due to excretion.

GROWTH AND SURVIVAL OF PACU *Piaractus mesopotamicus* LARVAE FED FORMULATED DIETS AND LIVE *Artemia*

□

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Pacu *Piaractus mesopotamicus* is a well-established aquaculture species in South America especially in Brazil due its fast growth, rusticity and market acceptability. However, in order to maximize the production, the larval rearing phase must be improved to secure higher juvenile survival and growth.

A feeding experiment tested the acceptance of formulated and commercial diets and their effects on the transition from live to compound diets, growth and survival of pacu larvae. Further analysis will address activities of digestive enzymes and histological appearance of the liver and pancreas. Pacu larvae were obtained from induced spawning at the Aquaculture Center. During the yolk sac absorption and the following period of *Artemia* nauplii feeding (day 4-13), larvae were kept in a 100 L flow through system. After this initial period larvae were counted and transferred to the experimental units. They were stocked at the density of 25 larvae per liter in 10 L tanks also in a flow through system with a constant temperature of 29 °C. The amount of *Artemia* and the artificial diet offered daily was 5% and 10% of the biomass, respectively. The co-feeding period lasted for 3 days and then larvae were offered the artificial diets for 16 more days. Two controls were used, one fed exclusively with *Artemia* nauplii for the whole period and a negative control, where larvae were fed with nauplii during the first 3 days and then starved. The artificial diets were a commercial diet (Bio Kyowa), and two experimental diets based on casein-gelatin and supplemented with freeze-dried beef liver (Beef) or extract from maca (*Lepidium meyeri*).

The final survival among the four treatments did not differ statistically (P<0.05). *Artemia* fed group had

final survival of 91.5% compared to the others treatments, which ranged between 76% and 81%.

| Days from transition | 1 | 4 | 10 | 16 |
|----------------------|-----------|--------------------------|--------------------------|--------------------------|
| <i>Artemia</i> | 7.8 ± 1.9 | 22.5 ^a ± 0.1 | 33.1 ^a ± 6.2 | 56.9 ^a ± 7.4 |
| Casein-Beef | 8.0 ± 0.6 | 9.8 ^{bc} ± 1.7 | 15.2 ^{bc} ± 2.8 | 37.5 ^b ± 4.0 |
| Kyowa | 7.4 ± 1.3 | 17.2 ^{ab} ± 5.8 | 23.2 ^b ± 3.4 | 42.6 ^b ± 5.1 |
| Casein-Maca | 7.4 ± 0.8 | 12.2 ^{bc} ± 0.5 | 20.2 ^b ± 1.5 | 44.6 ^{ab} ± 4.6 |
| Starvation | 7.2 ± 0.3 | 6.0 ^c ± 0.6 | 6.5 ^c ± 0.9 | |

Means with different superscripts within columns are significantly different ($P < 0.05$)

Table 1. Weight (mg, mean S.D.) of pacu larvae (initial weight 5.2 1.7) during the experiment

INTEGRATED CAGE-CUM-POND AQUACULTURE SYSTEMS: STOCKING DENSITIES OF CAGED HIGH VALUED SPECIES IN CARP POLYCULTURE PONDS

□

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In integrated cage-cum-pond aquaculture systems, high valued species are stocked in cages suspended in ponds, and filter-feeding species are stocked in open water outside the cages. In such systems, high valued species are fed with high protein diets, while the filtering feeding species depend solely on natural foods derived from feeding wastes. The integrated cage-cum-pond aquaculture systems have been developed by stocking either hybrid catfish (*Clarias macrocephalus* x *C. gariepinus*) or large size Nile tilapia (*Oreochromis niloticus*) in cages and small Nile tilapia in open water.

Three experiments are being conducted to adapt the integrated cage-cum-pond aquaculture systems in carp polyculture ponds in Bangladesh, Nepal and Vietnam, to determine appropriate stocking density of caged high value species, to assess growth and production of fishes in both cages and open ponds, and to assess the economic and environmental benefits of this integrated system. Indigenous high valued species selected to stock in cages are stinging catfish (*Heteropneustes fissilis*) in Bangladesh, sahar fish (*Tor putitora*) in Nepal, and climbing perch (*Anabas testudineus*) in Vietnam. There are four stocking densities of caged species and one control without cages for each experiment. One cage of 1 m³ is suspended in each pond. Stinging catfish and climbing perch were stocked at 50, 100, 150, and 200 fish/m³ in cages, while sahar fish were stocked at 5, 25, 50, and 100 fish/m³ in cages. Chinese and Indian major carps were stocked at 1 fish/m² in open water. Caged fish are fed twice daily with locally available home-made feed or commercial pelleted feed at rates of 5%, 3% and 2% body weight per day during the first, second and remaining months, and no feed or fertilizers are added into open ponds. The control ponds are fertilized using local fertilization regimes.

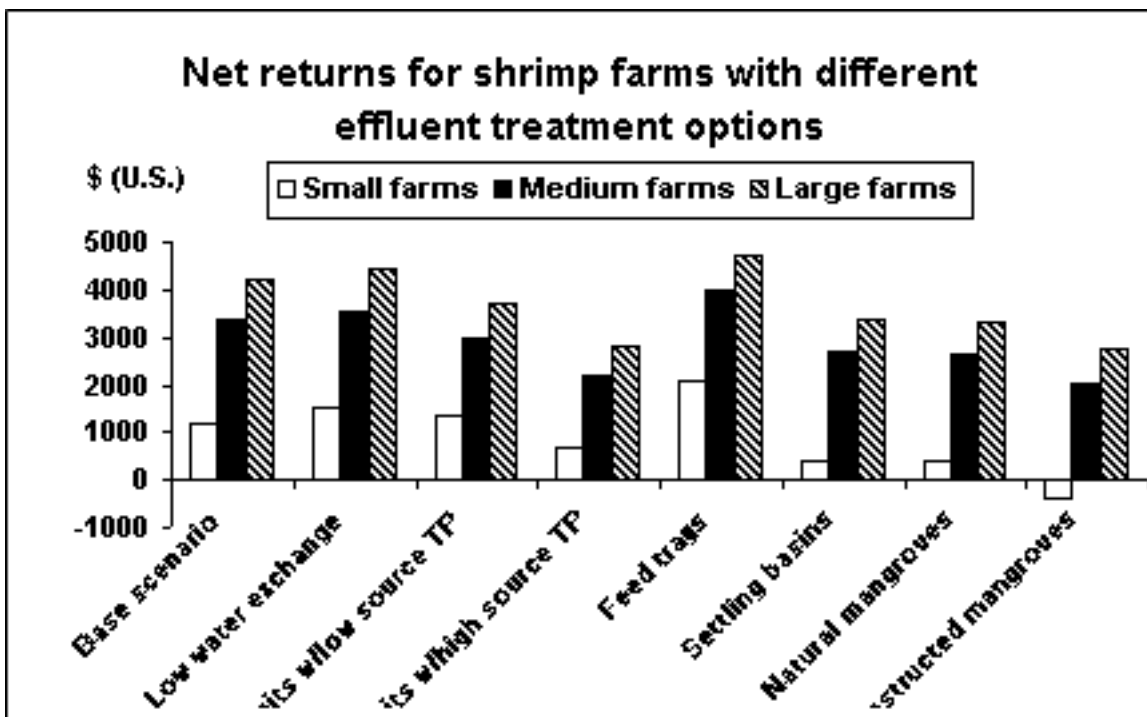
Water quality parameters are measured biweekly. Soil and fish are sampled at the beginning and end of the experiments, while feed and/or ingredients are sampled monthly, for analyses of moisture, total nitrogen and total phosphorus. Nutrient budgets will be determined, and partial enterprise budgets will be estimated to assess costs and values of fish crops.

ECONOMICS OF BEST MANAGEMENT PRACTICES (BMPs) FOR SEMI-INTENSIVE SHRIMP FARMS IN HONDURAS

□

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The shrimp farming industry in Central America has experienced remarkable growth and is one of the leading sources of foreign exchange. However, criticism has emerged on potential negative environmental and social externalities associated with shrimp farming. Best Management Practices (BMPs) to improve production efficiency and to ameliorate potential impacts on the environment are promoted by the Global Aquaculture Alliance. An economic optimization model with an environmental component was used to evaluate effects of five specific BMPs on profitability, optimal management strategies, and net quantities of nutrients discharged by semi-intensive shrimp farms in Honduras. The BMPs analyzed were: 1) reduction of water exchange rates from 10 to 5%; 2) reduction of production levels to meet nutrient discharge limits; 3) feed trays; 4) settling basins for the last 10% of drainage effluents; and 5) partial recirculation of effluents through a mangrove biofilter. Results indicated that the BMPs targeted at improving production efficiency (reductions in water exchange rates and feed trays) had the greatest potential to reduce net discharges of nutrients, and increased profit margins. Reduced water exchange increased net returns above all costs of production by 27%, 6%, and 4% for small, medium, and large farms, respectively while the use of feed trays reduced FCR and increased profits. Shrimp farms in Honduras met both initial and target standard concentrations for TP and BOD 5 during routine water exchange. Very low exchanges of 2% of total farm volume would require farm management adjustments of different stocking densities and production cycles that reduced profits by 0-42%, depending upon the level of nutrients in the incoming source water for the farm. Settling basins increased investment capital requirements and changed management strategies that affected cash flow. Net returns above total costs decreased by 66% and 20% for small and medium and large farms. The use of mangrove biofilters was the most expensive treatment option considered. While appealing from an environmental perspective, the use of mangrove biofilters is not currently feasible economically.

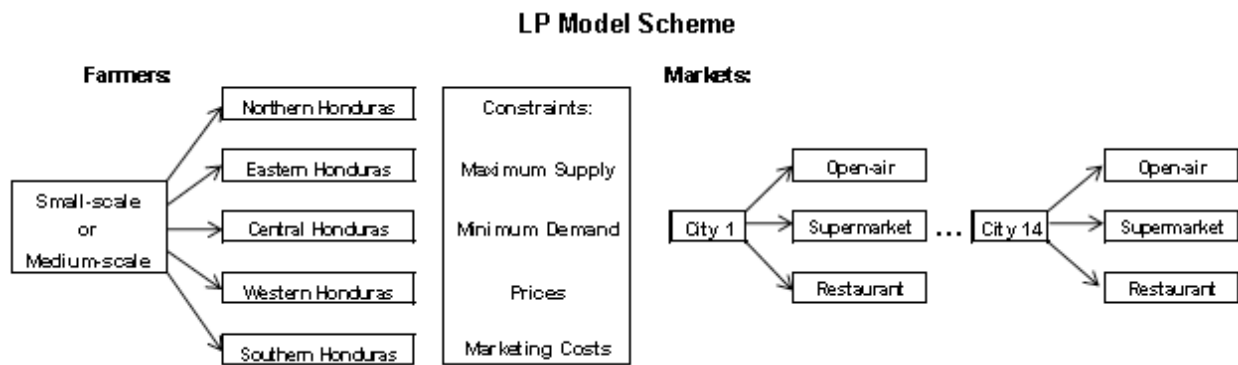


OPTIMIZING TILAPIA MARKETING IN HONDURAS

□
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Honduran production of tilapia has increased in recent years. However, lack of thorough understanding of domestic markets and lack of coordinated production efforts have hampered development of a domestic market. Five main production regions in Honduras were defined based on geographic location, production and marketing conditions. Maximum supply volumes were determined from cultivated area, production system employed and estimated output. Two farm-size scenarios were considered; 1) small-scale farms, operating less than 1 ha of ponds and 2) medium scale farms having from 1 to 12 ha of water surface area. The two farm groups represent the majority of Honduran tilapia producers. Minimum quantity demanded was estimated for 14 potential market towns based on income level, per capita consumption, and population. Information on relative volumes, prices, product forms, and preferences for tilapia in open-air markets, supermarkets and restaurants, were taken from previous surveys conducted in Honduras and from secondary data. Direct and indirect marketing costs evaluated included: delivery transportation expenses, volume of shipments definitions, labor, packaging, icing, promotion and financing for every potential combination of farm size/location and prospective market location/channel. A profit-maximizing linear programming (LP) model was developed to determine optimal distribution combinations from farms to potential markets. The spatial allocation of the farms and markets supports the use of a Transportation LP model. The algorithmic LP model processes all possible combinations of deliveries and calculates potential profits. The solution is reached when the sum of profits acquires its maximum value

given specified constraints. Longer marketing channels generate higher costs and shorter channels yield better quality and prices under current Honduran conditions. While it has been demonstrated that supermarkets and restaurants are willing to offer tilapia, the underdeveloped nature of these markets makes it difficult for farmers to sell directly at the retail level. Reliable sourcing and constant quality may allow tilapia growers in Honduras to cultivate domestic markets as an alternative to export markets. Further research is needed to evaluate the feasibility of processing, seasonality and the effect of different tilapia strains on the Honduran market.



THE ROLE OF NONGOVERNMENTAL ORGANIZATIONS IN AFRICAN AQUACULTURAL DEVELOPMENT

□

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Aquaculture is one path toward diversifying farming systems, improving food security for some segments of the population, and augmenting the rural economy. Aquaculture remains a small part of the food supply in Africa, yet there is potential for it to play an important role in some locales for the most food insecure segments of the population.. The Third Sector of non-profit, nongovernmental organizations (NGOs) has been the focus of many recent efforts to overcome the inefficiencies and lack of responsiveness of central governments to rural people. Many isolated and small-scale, low-income farmers have not been served by the State agricultural extension system. NGOs organizations have filled in some gaps by reaching some of the poorest farmers with training and other services, using primarily international resources. Several NGOs in been leaders in developing innovative, farmer participatory research and extension methodologies and low-cost agricultural technologies that have been shown to increase production, slow migratory agriculture, and improve the farm resource base, farmer health, and the surrounding environment. This paper examines institutional and organizational issues shaping the role of NGOs in promoting the sustainable practice of fish culture in Africa. It argues for a more realistic set of expectations and cautions to guide efforts to utilize NGOs to promote aquacultural development, and suggests some steps that can be taken to counter the circumstances that undermine NGO effectiveness in serving the rural sector.

SUSTAINABLE INTERNATIONAL AQUACULTURE RESEARCH: A FOCUS ON LOW FOOD CHAIN SPECIES

□

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Since 1982, the primary focus of the Aquaculture Collaborative Research Support Program (ACRSP) has been on constructing strategies that provide sustainable sources of finfish for local consumption. A mounting emphasis on low trophic species has emerged while executing these strategies. As the program addresses topics such as aquaculture effluent, fish feed and nutrition, production systems, and indigenous species development in host countries there is a natural tendency and concerted effort to study low trophic species due to their positive attributes for aquaculture. Benefits of rearing low food chain species include improved feed costs, improved water quality, less infrastructure, increased farm profits, and improved production. As the ACRSP looks to the future, emphasis on studying aquaculture species that thrive on low food chain diets will continue to intensify.

AQUACULTURE CRSP BUILDS ON FOUNDATION AND EXPLORES FUTURE COLLABORATION

□

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The Aquaculture Collaborative Research Support Program (ACRSP) continues to build on a strong foundation of research and extension, while investigating new avenues for direct impact. The ACRSP addresses aquaculture research and development constraints through core Host Country institutions based in Honduras, Mexico, Peru, Brazil, Thailand, Philippines, Vietnam, Bangladesh, South Africa, and Kenya. In addition, the program is funding new investigative projects for a watershed project in Kenya, country assessments for future aquaculture research in Tanzania and Ghana, and an exchange program for extension and governmental personnel throughout Latin America and the Caribbean. Researchers are addressing a diverse array of themes from production system design to environmental analysis to indigenous species development. Currently, 28 US PI's from 14 US institutions and 35 Host Country PIs are participating in new or continuing ACRSP projects in 21 countries. As the program looks to the future there will be increasing focus on watersheds, community involvement, and food production through fisheries and aquaculture.

CONTROLLED REPRODUCTION OF INDIGENOUS SPECIES TO PREVENT THE LOSS BIODIVERSITY: A CASE STUDY OF HERBIVOROUS SPECIES *Spinibarbus denticulatus* IN SOUTHEAST ASIA

□

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Asian Institute of Technology
Thailand

Chinese, Indian major carps and tilapias make up over 90% of freshwater species cultured and over 95% of this comes from Asia. All of these species are exotic and non-native to Southeast Asia. Although, culture of some introduced species is profitable, they have also been implicated in either displacement of indigenous species or introgression with local species. Consequently, local indigenous species composition is negatively impacted. Additionally, exotic species are susceptible to indigenous pathogens. For example, grass carp is prone to local environmental stressors such as the red spot disease (presumably a viral disease). *Spinibarbus denticulatus*, is an example of an indigenous species which has a significant potential for aquaculture, particularly for a low-input system. This species lends well to organic farming. This is a herbivorous species with a diet consisting of plankton and macrophytes, very similar to that of the grass carp. One of the most attractive features of this species is that it is resistant to red spot disease, even when grown together in the same cage with infected grass carp. It is also an economically important species and has been cultured, for a several decades, primarily by stocking in ponds and cages with seeds collected from the wild. Culture of this species is constrained by a limited supply of seed and a lack of wider market. Up to date, there has been no formal study that characterizes basic biology and reproduction of this species. Our preliminary study in North Vietnam indicated that this species could be spawned in captivity and respond well to natural and hormonal stimuli for spawning. This was followed up by a more rigorous study on reproduction. The results of these studies will be presented and discussed.

NITROGEN AND PHOSPHORUS CONCENTRATIONS AND LOADS IN A STREAM RECEIVING CATFISH FARM EFFLUENTS

□

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Big Prairie Creek and its tributaries in west-central Alabama receive effluent from about 5,000 ha of channel catfish ponds. Concentrations of nitrogen and phosphorus were monitored in Big Prairie Creek, its tributaries, and control streams without catfish farms on their watersheds. Measurement of nitrogen and phosphorus also were made 0.5 km above and below the confluence of Big Prairie Creek with the Black Warrior River.

Total nitrogen and total phosphorus concentrations increased as water passed downstream in Big Prairie Creek. The loads of nitrogen and phosphorus carried by the stream increased by 23.6 tons/year and 163 tons/year, respectively, between a station upstream from catfish farms and a downstream station receiving

effluent from an estimated 2,994 ha of catfish farms. These loads were 94.6 % and 55.7% of estimated annual discharge of nitrogen and phosphorus in effluents from catfish farms in the area contributing runoff between the two sampling stations. As water passed downstream, there tended to be an initial increase in total ammonia nitrogen concentration. This increase was followed by a decline in ammonia nitrogen concentration and an increase in nitrate nitrogen concentration as the result of nitrification. Also, the ratio total phosphorus:soluble reactive phosphorus tended to decline as water moved downstream suggesting that phosphorus in particulate organic matter was being mineralized. Total nitrogen and total phosphorus concentrations declined in the area where the creek forms lake Demopolis, but they were still higher than in the upstream reach which did not receive catfish farms effluent.

Although Big Prairie Creek has large nitrogen and phosphorus inputs from catfish farming and possibly other activities, concentrations of nitrogen and phosphorus were no greater in Big Prairie Creek and its tributaries than in control streams in the same ecoregion which did not have catfish farms on their watersheds. Also, the inflow of Big Prairie Creek did not cause an increase in nitrogen and phosphorus concentrations in the Black Warrior River.

**INCOME, FOOD SECURITY, AND POVERTY REDUCTION:
CASE STUDIES OF SMALL-SCALE AQUACULTURE PRODUCERS
IN SANTA BARBARA, HONDURAS.**

□

Elizabeth Trejos-Castillo*, Joseph J. Molnar, Pablo Mart
E. William Tollner, Brahm Verma, George Pilz,
Suyapa Triminio Meyer, Dan Meyer

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With very few exceptions, rural aquaculture in the Central American region is not properly integrated into government structure and policy frameworks. Studies suggest that small-scale aquaculture projects in Central America have had some success, although it has been limited. Structural policies have reduced the governments' capacity to promote and develop aquaculture oriented towards the production of cheap products for the poor. In Honduras, poverty represents one of the major problems of the rural areas where individuals suffer from the lack of access to land titles, credit, and appropriate technology for their livelihood improvement. The adoption of aquaculture practices have been a long-term process in which socio-cultural as well as economic and political factors have played a determinant role. Major difficulties encountered in promoting aquaculture in the country are not linked to existing physical resources, but mainly to institutional factors, as well as to research and entrepreneurial capacity.

The purpose of this study is to identify socio-economic factors leading to the successful adoption of tilapia culture by subsistence farmers and small tilapia producers at Santa Barbara, Honduras. Subsistence and small farmers' reasons for initiating, continuing, or stopping tilapia culture as well as the advantages or disadvantages of the enterprise are evaluated in the study. Results suggest that the extended relationship with a local non-governmental organization is clearly one of the reasons for the sustain

practice of fish culture at the study communities. Farmers also rely on the NGO to provide technical support and seed supply.

Role of women in aquaculture development programs and research at the rural areas is also an important fact to be evaluated. Women play determinant roles at almost any all the stages of the adoption of the aquaculture innovation throughout the maintenance of the enterprise. The role of public sector, non-government organizations and donor support in promotion of small-scale aquaculture is determinant for the adoption of aquaculture enterprises among the poor. Mainly due to the lack of coordination and unification of such organizations, the rate of adoption of aquaculture has been lower than expected in Honduras.

Appendix 1a

Minutes of the 2004 Program Meeting SATURDAY, 4 MARCH 2004 HONOLULU, HAWAII

CALL TO ORDER

Director Hillary Egna called the meeting to order at 8:30 a.m.

PROGRAM MANAGEMENT OFFICE INTRODUCTION AND WELCOME

Director Hillary Egna's introductory remarks included a note of Technical Committee members (Appendix 1), a welcome and a review of CRSP-sponsored WAS award winners (see Appendix 2). Thanks were given to Kevin Fitzsimmons for organizing CRSP awards and to PMO staff for organizing the meeting and events.

Meetings of interest were noted, including ISTA, future WAS meetings, and IIFET in Japan.

The status of the CRSP program was reviewed. The CRSP grant will run through August 2004, with an extension anticipated possibly through July 2006. If the CRSP is extended, and a given project has completed work and submitted final reports by August, and if its Eleventh Work Plan proposal had highly ranked, currently unfunded investigations, then that PI may receive funds for the second phase of the Eleventh Work Plan. If a no-cost extension until August is needed, email Hillary Egna.

Within USAID, the Aquaculture CRSP was moved to the Office of Environment and Natural Resource Management (from Agriculture) about two years ago. We are part of the Water Team. USAID commissioned reviews of three agriculture subsectors—integrated pest management, sustainable agriculture and natural resources management, and aquaculture—in 2002–2003. Reviewers of the aquaculture subsector were Barry Costa-Pierce, Ron Hardy, and Jim Kapetsky. As a result of the reviews in their respective sub-sectors, the IPM and SANREM CRSP are being re-bid.

Due to fortuitous timing, Aquaculture CRSP anticipates a two-year extension, with level funding. After that it is uncertain whether CRSP will continue in its present form. There is a need to show the Aquaculture CRSP is an impressive program and to address current USAID foci. USAID focus is presently on Iraq, Afghanistan, Somalia, Sudan and Liberia, not countries in which the CRSP has had a strong presence, and focus is also on USAID Missions more heavily than in the past. There is a need to receive more reports of new success stories. Economic returns on investment will require discussions between the Host Country Principal Investigators and US Principal Investigators.

For the next two years, the Water Team (headed by Alan Hurdus) wants outreach, training and impacts.

Plans for the next program meeting were opened to the floor. Some CRSPs do not have an annual meeting. Hillary Egna called for thoughts on what the suitable period was for full program meetings.

Suyapa Triminio Meyer suggested holding regional CRSP meetings yearly and full program meetings biennially. Yang Yi proposed holding meetings in host countries. Jim Diana noted that tying together the CRSP and WAS meetings avoids the need to present science papers at the CRSP meeting. The tie-in of the CRSP program meeting and WAS keeps the CRSP meeting to business only. Kwei Lin, Nancy Gitonga, and Kwamena Quagrainie commented on the need to set up an Africa chapter of WAS.

Hillary Egna proposed a motion: To hold regional meetings in alternate years with full program meetings to be held every two years. Motion passed unanimously.

PMO Assistant Director Danielle Clair gave an overview of TraiNet, a new USAID system to track trainee travel. The system is not yet finalized, and institutions may vary on how they deal with TraiNet. Some institutions will not use it at all as they do not want to accept liability. Harry Rea commented that the system is still in a refinement stage.

Danielle Clair mentioned that the “Ponds for Life” CRSP DVD is now complete and will be made available to PIs and CRSP associates. Yang Yi asked if the DVD would be made available in different languages. Danielle Clair replied there were no plans at present to do this due to limited funding, but it may be possible to put subtitles in the clips in the future.

USAID Cognizant Technical Officer for the Aquaculture CRSP Harry Rea gave an overview of USAID. The future of the CRSPs may focus on natural resource management and the need for field support to USAID missions. Other topics included the USAIDs reorganization, the move of CRSP from Agriculture to Environment (Water Team), and the sub-sector review.

Hillary Egna thanked the Technical Committee co-chairs.

Appendix 1b

Aquaculture CRSP Award Recipients World Aquaculture Society Meeting 1–5 MARCH 2004 HONOLULU, HAWAII

The Aquaculture CRSP sponsored numerous awards at the 2004 meeting of the World Aquaculture Society in Honolulu, Hawaii. In conjunction with the opening day ceremonies at the main WAS meeting, long-time CRSP researcher C. Kwei Lin, from The University of Michigan and the Asian Institute of Technology, was presented with an Aquaculture CRSP Lifetime Achievement Award for his many years of service.

In addition to sponsoring 7 student and 3 professional pre-conference awards, the CRSP also awarded prizes for the best and two runner-up Student Posters. Eligibility rules for a pre-conference award included that the research presented be based on CRSP-sponsored work, but the Student Poster Award was open to all presenters. Winners' names are presented below.

Student Pre-conference Awards

Fred W. Chu-Koo, Southern Illinois University at Carbondale
Seed Dispersal by Frugivorous Amazonian Fish

Eddie Boy T. Jimenez, Central Luzon State University
Cost Containment Option in Semi-Intensive Tilapia Culture: Evaluation of Alternate Day Feeding Strategy

M.E. Palacios, The Ohio State University
Growth and Morphological Changes in Digestive Tract of Rainbow Trout and Paku due to Fish Meal Protein Replacement with Soybean Products

Gustavo Rodriguez, The Ohio State University
Evaluation of Two Phytochemicals, Genistein and Quercetin as Possible Sex Differentiation-affecting Agents in Tilapia nilotica by Dietary Administration

Kom Silapajarn, Auburn University
Particle Size and Reaction of Agricultural Limestone

Orawan Silapajarn, Auburn University
Nitrogen and Phosphorus Concentrations and Loads in Stream Receiving Catfish Farm Effluents

Elizabeth Trejos-Castillo, Auburn University
Income, Food Security, and Poverty Reduction: Case Studies of Small-Scale Aquaculture Procedures in Santa Barbara, Honduras

Professional Pre-conference Awards

Suyapa Meyer, Escuela Agricola Panamericana

Tilapia Fingerling Producers in Honduras: Characteristics, Practices and Needs

Christopher Knud-Hansen, Michigan State University

Potential for using Clinoptilolite Zeolites for Ammonia-N Transfer and Retention in Integrated Aquaculture Systems

Ivano Neira, University of Arkansas at Pine Bluff

Restaurant Markets for Aquaculture Products in Peru: A Descriptive Analysis

Student Poster Awards

First Place

Anthony Ilano, Hokkaido University, Japan

*The development and hatching, growth, and survival of juvenile Japanese whelk *Buccinum isaotakii* in different temperatures and diets*

Second Place (two awards)

Nilton Massuo Ishikawa, Aquaculture Center of UNESP, Brazil

*Safe concentrations of mercury in waters destined to *Oreochromis niloticus* rearing*

Antonio Lozano-Leon, University of Santiago de Compostela, Spain

A qualitative study of marine phytoplankton in the coastal areas of Honduras of interest for the bivalve molluscan culture

Appendix 2

Minutes of the 2004 Technical Committee Meeting

SATURDAY, 4 MARCH 2004

HONOLULU, HAWAII

CO-CHAIRS' OPENING COMMENTS

Jim Diana gave an overview of the Technical Committee, including the role to advise the Management Entity and to advise on future direction. He cited a need for excellent proposals and that projects ought to originate from Host Countries. The greatest strength of the CRSP is the involvement of people.

Chris Brown gave an introduction to project presentations.

PROJECT PRESENTATIONS

Mexico – Watershed Management

Carl Schreck outlined on-going research in Mexico, including methods of sex control, alternative compounds, and methods of exposure. The aim is for better ways of controlling sex with “clean” technology and avoiding environmental persistence. Work is proceeding on three alternate species and hormone treatments using *Artemia*. A brochure was published on tilapia available from Tabasco State. Outreach to small farmers included three workshops in Mexico and extension products (e.g., leaflets). Successes have been achieved in gar, tilapia, and native cichlid production. Wilfrido Contreras-Sánchez was appointed as a CRSP Ambassador who will serve as a liaison to the USAID Mexico Mission. The project has received significant (1:1) matching funds from Mexico.

Peru – Aquaculture Production

Chris Kohler discussed the Peruvian Amazon project, including the focus on indigenous species. Several papers have been published. Training efforts now include the entire Amazon. Aquaculture has expanded considerably in the region. Salvador Tello gave an overview of the Amazon project. Efforts include raising seed stock and training. The regional government (of Loreto Department) has signed agreements allocating \$2M to support aquaculture.

Central America – Aquaculture Production

Joe Molnar noted that successes in Honduras have spread to neighboring countries. As the coffee industry declines there is increasing interest in diversifying into other forms of agriculture such as aquaculture. Ongoing work includes compiling a regional database of fingerling suppliers, since the supply of fingerlings is a bottleneck to expansion. Dan Meyer mentioned that the Honduras work includes training, meetings, a fingerling study, and a cost-of-production and economics study. Strong interest in tilapia continues in Honduras.

Philippines – Aquaculture Production

Chris Brown mentioned that the Philippines project has focused on Luzon Island since 80% of fish production occurs there. Tilapia farmers susceptible to losses are therefore trying to reduce cost of production, including delayed onset of feeding, feeding at sub-satiation, and feeding on alternate days.

These new protocols reduce feed costs, increase profit, and reduce pressure on the environment. The doctoral project of Vera-Cruz is to study IGF-1 as an instantaneous test of growth characteristics. A new experiment underway is looking into the effects of fingerling size on survival and size of fish at harvest. The web-based information center has been successful.

Southeast Asia – Aquaculture Production

Amrit Bart gave an overview of work in four different countries. A primary aim is to develop environmentally responsible aquaculture. Areas of activity include waste utilization, indigenous species, outreach programs, and workshops.

Global Project – Watershed Management

Claude Boyd described how work in South Africa and Brazil is progressing. Efforts include research on how soils differ in ponds of different ages and the composition of pond bottom soils. The research is also looking at effects of too much lime in ponds.

Global project – Health, Welfare, and Human Nutrition

Eladio Gaxiola-Camacho (translator, Ambrocio Mojardin-Heráldez) focused on tilapia and water quality, role of women in tilapia aquaculture, use of agrochemicals, Best Management Practices, and public health in Mexico.

Africa – Aquaculture Production

Jim Bowman summarized work just completed from the Tenth Work Plan. Ongoing Eleventh Work Plan activities include two main areas—aquaculture training and *Clarias* studies. Training efforts include producing a handbook/training manual, holding Farmer’s Field Days, and conducting on-farm trials.

Africa – Aquaculture Production

Kwamena Quagrainie noted the interest to expand activities to Tanzania and Ghana, and work planned for this, including site evaluation, description, and development planning. Kajitanus Osewe from Tanzania was introduced and offered his greetings and appreciation.

Africa – Watershed Management

Bill Tollner provided background on the Nzoia River watershed project. The origins of interest in watershed management in Kenya derive from the need to be proactive as the number of stakeholders and uses of the resource increase.

CARRY-OVER TENTH WORK PLAN ACTIVITY UPDATES

Carole Engle summarized marketing projects, including development of guidelines for domestic marketing outlets. A questionnaire was developed for market surveys, including a rapid market assessment tool. Work is ongoing in Central and South America and in Kenya. A training manual is under development.

Nancy Gitonga outlined information on the strain experiment, noting considerable interest in the Lake Victoria strain. The feeds experiment project includes a training program on feed formulation and production. Ron Phelps mentioned that the strain evaluation work at Auburn compared the Ivory Coast strain with an Egypt and two Kenya strains. In reproductive performance domestic strains were better, but

in growth there was no difference. The Ivory Coast strain showed some inbreeding but performed as well, raising questions on the need to introduce new strains.

Brahm Verma outlined achievements on the Honduras Project. The focus is to institutionalize knowledge, by developing a model for organizing knowledge. This effort is primarily web-based. In four years 1,500 people from four countries were trained in decision-making website training sessions. The project formed the Tilapia Connection, a coordinating group.

INSTITUTIONAL REVIEW BOARD ISSUES WORKSHOP

Human Subjects and Animal Use Protocol

Chris Brown opened with comments on university compliance issues. Animal care and use research is subject to Federal Government (NIH and USDA) rules. Exemptions (e.g., for agriculture) are available but Principal Investigators must still have paperwork on file. Most concern is for mammals and LD₅₀ experiments. Standards are applied to all vertebrates and sometimes invertebrates. There are penalties for non-compliance. The exemption issue is between the Principal Investigator and his or her institution. A recent trend is for more methods to be used to enforce the standards. Responsibility for meeting Host Country standards is with PIs in the US.

Carole Engle noted that standards are available on-line (AquaNic) as published procedures. Chris Kohler suggested that the nature of the project should guide experimental method and protocols. Claude Boyd pointed out the lack of control on the collaborators, yet there remains a degree of liability for the PI. Chris Brown noted that in any case the university would be inspected. Carl Schreck noted that concern is greater in Europe, but the US will likely be adopting similar standards. Jim Diana pointed out that legislators have not focused on human use in surveys, but this may change. Joe Molnar said that the process is positive, as it enhances the quality of research, ensuring use of appropriate terminology.

Hillary Egna pointed out that as prime grantee Oregon State University has to ensure that subcontracting institutions have processes in place. Prior to allocation of funds OSU has to ensure the PIs have gone through their institutions' processes, submitting their projects for review. Human subjects rules must be followed and can be "thornier" than animal subjects, and informed consent rules must be observed.

WHITE PAPERS AND POLICY DEVELOPMENT

Discussion within the topic areas led to the consensus that White Papers guide policy rather than set it and that the White Papers represent a position but not necessarily formal policy. For example, a White Paper may represent a position that is concordant with or actually contrary to an officially adopted formal policy. Jim Diana posed the question of what should be handled by institutions, and what by the CRSP. White papers were produced four to five years ago and have been reviewed and edited at CRSP meetings. They are not policies so it is necessary to think about their meaning. Dan Meyer said each major issue deserves a position statement. Chris Brown said the CRSP could produce position statements on some issues but not others. Amrit Bart said the White Paper should be used as a means of producing position statements; the paper itself should not be the position. Konrad Dabrowski said that White Papers are "living documents" and could be upgraded over time. In contrast, the policy mandates how particular CRSP actions, activities, or affairs are to be managed. Brahm Verma asked how White Paper topics were selected. Jim Diana answered that the TC reviews the subjects prior to selection for discussion. Hillary

Egna and Danielle Clair mentioned that white papers are not proposals but meant to guide research within the organization. Brahm Verma asked if a position statement would define which future projects would be funded. If CRSP writes a policy, then they need activity to support it (Otherwise, why is there a need to take a position?).

Also emerging from the discussion was the notion that a position, and indeed policy, on significant issues could be predicated on other organizations' formal statements such as those of USAID or FAO. In each case, a decision would have to be made on whether to accept the external organization's unmitigated statement, or whether to refine the position to one better meeting the CRSPs needs.

Indigenous Fish Species and Biodiversity

Following thoughtful input from many of the attendees, the main actionable items were to use the FAO and AFS statements as the basis for CRSP policy, with refinements as necessary. In particular, this would encourage work on indigenous species and on existing non-native species (such as tilapia) in regions where they have already been introduced. Joe Molnar suggested the CRSP website should have links to the FAO position statement. A motion was proposed to establish a policy on use of indigenous species but there was no formal vote. However, a committee was formed to prepare a position statement to be ready by June 2004 for circulation to and comment by the TC. Committee members are Hillary Egna, Amrit Bart, Wilfrido Contreras-Sánchez, and Chris Kohler.

Chris Kohler proposed the use of the abundant existing literature on indigenous species. Nancy Gitonga said that only Southeast Asia is in the present in the four-year old White Papers and CRSP should look into culture of indigenous fish in Africa. The FAO has a code of conduct and AFS also has an indigenous species statement. The CRSP could use the FAO guidelines as the position statement if the FAO position covers CRSP needs. This makes sense since the FAO guidelines are international. Work should be within those guidelines but also consider the most appropriate species for solution.

Chris Brown suggested that if made into policy, there should be defense of using “domesticated” animals, in which case use of tilapia was acceptable. Use of indigenous species should be developed and work on domesticated animals should continue as needed. Wilfrido Contreras-Sánchez cited importance of working with tilapia because of its role in regions where it is already established—even though it is an exotic. If a species was introduced historically, then it should be used—in the proper manner.

Christine Crawford asked if there was any policy on the movement of species from one place to another. There is no policy on this so CRSP may want to address both issues. A committee could be formed to look over this. Carl Schreck mentioned a need to look at the impact of non-indigenous species. He recommended carrying out environmental impact analyses prior to their use.

Biotechnology, Genetics and Disease Issues in Aquaculture

The main concern on this issue was whether or not the CRSP needs to take a position on biotechnology, given the topic's propensity to generate controversy. Hillary Egna asked the group what direction the CRSP would like to take. Hillary Egna pointed out that CRSP researchers have to follow USAID policies, but these are broader than what CRSP might consider. USAID policy may be the minimum; does the CRSP want to raise the bar? The USAID minimum is substandard—established without much thought given to aquatic environments; it does not consider aquaculture or fisheries. The consensus (and motion proposed by Chris Brown passed unanimously in favor) was that the CRSP should prepare a position

statement based on adherence to USAID guidelines. The TC would make a short statement that CRSP is operating within existing USAID guidelines, perhaps highlighting CRSP concerns, for review and editing by the TC. Dan Meyer seconded the motion. The statement would be prepared by a committee composed of Dan Meyer, Chris Brown and Wilfrido Contreras-Sánchez. When passed by the TC the statement would be posted on the CRSP website.

Chris Brown said that disease was not much addressed in the White Paper, and there may be some benefits to having a position or policy. CRSP is not much involved in biotech, but it is a direction CRSP is headed in, yet there is a problem with perception of biotechnology (defined as DNA-based science). For example, the European Union has a strong, radical stand. Therefore we need recommendations for biotech. Biotech has “strings attached” (for example, if it is proprietary information) making biotech benefits inaccessible in poor countries. CRSP research should result in intellectual property that can be transferred and that is free. The White Paper draft can be used as a set of guidelines.

Carl Schreck questioned if a policy is needed for something that is just a diagnostic tool. Chris Brown said researchers should have the freedom to explore. Carl Schreck said that use of Genetically Modified Organisms (GMOs) does require “language.” Chris Brown said that it needs to make the distinction that biotech is not a “bad thing.”

Carl Schreck said it is necessary to broaden the definition of biotech, for example to include vaccines. Jim Diana commented that not everything can be included in a statement and the question is if a policy is needed or not. A statement on GMOs would be needed, and selection has already been given the okay.

Chris Brown said the CRSP would be more conservative (than USAID) if the policy was not to support work on GMOs, since USAID is already working on GMOs. Dan Meyer asked why CRSP should paint itself into a corner and so why not go with USAID's statement. Hillary Egna pointed out that the USAID statement did not deal specifically with fish and aquatic environments.

Chris Brown said balance is possible—a one or two paragraph statement that CRSP abides with USAID policy. The statement could be posted on the CRSP website, including a link to the USAID website's policy statement. The aim is for the technology to be accessible. Jim Diana asked why, if CRSP agreed to use the USAID policy, it was needed to do more. Chris Brown said a paragraph could be written about CRSP and GMOs. Nancy Gitonga suggested it should be left as is. Chris Brown said the purpose [of the White Paper] was to be proactive. Dan Meyer said he was willing to help out and asked whether other CRSPs have a GMO policy.

Carole Engle said the CRSPs strength is as a science-based organization addressing stakeholder needs. The policy in the future is unknown, and the CRSP can defend itself with the science. The aim is to recognize issues, subject studies to peer review, and ensure sound process. There is no need to be drawn into controversial issues. She seconded Dan Meyer's suggestion for just a simple short statement on the website.

Chris Brown said that research is driven by Host Countries, and Ron Phelps said that CRSP researchers need to take a position as responsible scientists. Jim Diana said CRSP can take a position if needed—there is no need to be wishy-washy. The CRSP can go along with what people want to do, and USAID does allow biotech work.

Carl Schreck pointed out the need to include caveats in biotech-related proposals. Yang Yi said there was no need to encourage or discourage particular kinds of research, just that CRSP policy is in accordance with USAID. Hillary Egna said that FAO has a biotech policy that could be referenced. Jim Diana said the choice is whether the committee wants to leave the White Paper as is or whether there is a need to scrutinize policies more closely. Brahm Verma said that CRSP might want a paper that could establish a position that can leverage support, and convince the funding agency.

Aquaculture Best Management Practices as a Possible Focus for Future CRSP Research

There were several exchanges over how codes of conduct should govern experimental research and which codes of conduct were best for the CRSP. This discussion resulted in agreement that present guidelines of FAO and AFS provide adequate codes of conduct for CRSP researchers. These would be linked from the CRSP website. The Committee agreed that there would be no more work on this.

Jim Diana said that CRSP should move toward research that supported codes of conduct. Boyd and Woods' White Paper outlined Best Management Practices for the CRSP.

Claude Boyd pointed out that FAO has codes of conduct, and that he is making a brochure for codes of conduct. This short statement would be on the website and in support of FAO and national codes of conduct. Carl Schreck said NIH and AFS have codes of conduct for researchers, and the CRSP should just refer to those codes. Claude Boyd said the FAO code is more appropriate. Kwei Lin said that there are other codes of conduct besides the FAO. Jim Diana asked if it was needed to refer to others. Kwei Lin said that researchers needed to observe the code of conduct in Host Countries.

Claude Boyd said their bulletin would cover the basics but a more specific review of what's been done would be forthcoming as a publication. Jim Diana said this could be used to put the statement together. The statement should be very general, as acceptable conduct might change according to changes in practice.

Kwei Lin raised the question whether experiments have to follow the code of conduct. Jim Diana said the codes of conduct should not be a constraint, but aquaculture promoted by the CRSP should follow the codes. Mucai Muchiri pointed out that codes of conduct are not laws but guidelines. Bill Tollner said that an end result might be whether an environmental organization or marketing group could certify fish produced following the codes of conduct.

Nancy Gitonga said the CRSP code needs to be explicit, to define good aquaculture practice, and to be forward-looking. She said there may be skepticism of statements on a product, so instead of codes of conduct, CRSP should just have guidelines.

Seed Production: The First Step in Successful Aquaculture

This discussion resulted in an agreement to write a position on seed issues, headed by Ron Phelps with Konrad Dabrowski to assist.

Chris Brown outlined the main issues concerning seed production, including the significance of inducing egg production or inhibiting spawning. Carl Schreck asked if the CRSP wanted a position on the use of

wild organisms, i.e., “mining” wild stocks for seed. Jim Diana asked whether the issue of using wild stock should be addressed.

Ron Phelps said that this White Paper was written not as a policy but with the intent to raise issues and highlight themes for future activities. Chris Brown asked if CRSP needed a policy on this. Ron Phelps said no. Chris Brown asked if anyone wanted a policy paper.

Konrad Dabrowski asked if the CRSP wanted to address “ramping up” (the level of intensification) in seed production, specifically regarding the use of larval feeds.

Mucaí Muchiri pointed out that ethical values might differ according to circumstances. For example, is it more ethical to use hormones to have fish grow bigger and faster and feed more people, or to not use hormones and let people die from hunger? It is necessary to think about broader impacts and what is more ethical.

Future White Paper ideas and future actions

Jim Diana called for other issues that may need policy papers. Kevin Fitzsimmons mentioned that WAS is putting together White Papers on several issues. He suggested that Claude Boyd be involved as he is working on many of the topics.

Nancy Gitonga asked whether there was a policy on fisheries enhancement via hatcheries. Jim Diana replied that there was none.

Yang Yi suggested the CRSP needed a White Paper on feed. Kevin Fitzsimmons noted that Geoff Allen is preparing a paper, and that the CRSP TC would obtain a copy and pass it around for comments.

TC Other Business and Closing Comments

Jim Diana announced the newly elected TC members. (Current membership is provided in Appendix 1.)

Joe Molnar asked for instructions for the Technical Progress subcommittee. Hillary Egna said that in general the TC subcommittees were not currently highly functional, as there was not a demand for them at this time. Jim Diana said that when there is a need to do something, the subcommittee will be called on. Hillary Egna said that this task will transition to regional committees and welcomed suggestions for how the committees could be more functional.

The meeting was adjourned at 3:40 p.m.

ADDITIONAL ITEMS

Hillary Egna offered the opportunity for people to make announcements.

Kevin Fitzsimmons gave a reminder of the ISTA meeting on 12-16 September at CLSU.

TC members to act as Regional Coordinators were announced:

- Asia: Yang Yi
- Central and South America: Suyapa Triminio Meyer

- Africa: Nancy Gitonga

Hillary Egna thanked members for attendance.

2004 Aquaculture CRSP Technical Committee Membership (through 2005 Annual Meeting).

| | INSTITUTIONAL AFFILIATION | AREA OF REPRESENTATION |
|---|---|------------------------------|
| CO-CHAIRS | | |
| Chris Brown 2005 | Florida International University | |
| Jim Diana 2006 | The University of Michigan | |
| MATERIALS & METHODS SUBCOMMITTEE | | |
| Claude Boyd 2005 | Auburn University | Production Optimization |
| Suyapa Meyer 2006 | Escuela Agrícola Panamericana Zamorano | Social & Economic Aspects |
| Yang Yi 2006 | Asian Institute of Technology | Environmental Effects |
| TECHNICAL PROGRESS SUBCOMMITTEE | | |
| Joe Molnar 2005 | Auburn University | Social & Economic Aspects |
| Bill Tollner 2006 | University of Georgia | Environmental Effects |
| Maria Haws 2006 | University of Hawaii | Production Optimization |
| WORK PLAN & BUDGET SUBCOMMITTEE | | |
| Dan Meyer 2005 | Escuela Agrícola Panamericana Zamorano | Production Optimization |
| Nancy Gitonga 2006 | Kenya Department of Fisheries | Social & Economic Aspects |
| Wilfrido Contreras-Sánchez 2006 | Universidad Juarez Autonoma de Tabasco | Environmental Effects |
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