



AQUACULTURE CRSP 21ST ANNUAL TECHNICAL REPORT

AMAZON AQUACULTURE OUTREACH

New Aquaculture Systems/New Species Research (10NSR1)

Final Report

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ABSTRACT

Outreach activities significantly benefited nearly 100 producers along the Iquitos-Nauta Road and in remote areas of the Peruvian Amazon. To assess the quality of extension services provided, producers were surveyed through a questionnaire to assess quality of extension provided and to obtain suggestions on how to improve the program. Two methods (“Master Aquaculturists” certification and “on-farm research”) were utilized to provide technical assistance in aquaculture techniques to local and prospective fish farmers. We certified four “Master Aquaculturists” and conducted “on-farm research” with paiche (*Arapaima gigas*) culture in ponds. In general, *A. gigas* exhibited excellent growth and survival, with observed growth rate being similar to reports by other authors using the same cultivation procedures. Additionally, the two extensionists provided aquaculture training to 321 vocational students, 8 teachers and 79 university students. Further, 40 individuals representing Ecuador, Bolivia, Brazil, Colombia and Peru were provided short aquaculture training courses. The final goal of the outreach program was reached through the creation of a website on Amazonian aquaculture; this website has become an important tool to communicate the work done by research institutions in the USA, most Amazon nations, and elsewhere (over 1800 hits last year alone).

INTRODUCTION

In South America, eight countries have USAID-presence status (Bolivia, Brazil, Colombia, Ecuador, Guyana, Paraguay, Peru, and Venezuela). Excluding Paraguay, these countries are linked by major river systems, particularly the drainages comprising the Amazon and Orinoco Rivers, which contain the highest diversity of freshwater fishes in the world. Accordingly, South America offers a special opportunity to develop appropriate technologies to cultivate alternative aquaculture species native to this continent.

In the Peruvian Amazon, three important institutions are working with aquaculture: Instituto de Investigaciones de la Amazonia Peruana (IIAP), Ministerio de Pesqueria (Peruvian Government), and Universidad Nacional de la Amazonia Peruana (UNAP). In the past ten years, they have produced millions of fry and have refined numerous aquaculture techniques. *Colossoma* and *Piaractus* are considered by local aquaculturists as the best fishes for commercialization in the tropical part of Peru. However, considerable potential exists to examine other species, as the Amazon Basin is home to over 2,000 freshwater species of fish.

A Memorandum of Understanding (MOU) is currently in place

linking IIAP, UNAP and Southern Illinois State University (SIUC) (and collaborating US universities with SIUC under this umbrella) into the CRSP network. IIAP and UNAP facilities include 49 earthen culture ponds ranging in size from 60 m² to nearly a hectare. Laboratory facilities exist to monitor water quality variables of ponds and conduct pertinent research on sustainable aquaculture development of important fish species native to South America. Facilities have been significantly upgraded and renovated at IIAP during Workplans 9 and 10. Outcomes of the Tenth Workplan have greatly facilitated the establishment of Peru as a full-fledged prime site for PD/A CRSP activities and research.

For the Tenth PD/A CRSP Workplan, four projects were funded: 1) Amazon Aquaculture Outreach, 2) Nutrition of *Colossoma macropomum* and *Piaractus brachypomus*, 3) Broodstock Diets and Spawning of *Colossoma macropomum* and/or *Piaractus brachypomus*, and 4) Studies on Reproduction and Larval Rearing of Amazonian Fish. These projects are extensions of research and outreach activities developed during the Ninth Workplan. Outreach and networking activities were undertaken to facilitate regionalizing the benefits of the CRSP. Previous hatchery problems at IIAP have largely been rectified and efforts concentrated on larval rearing, broodstock nutrition and development of growout diets (both prepared feeds and plant products for growout) for *C. macropomum* and/or *P. brachypomus*. Additionally, efforts were expanded to include two South American catfishes, *Pseudoplatystoma fasciatum* and *P. tigrinum*, both of which are attracting attention in South America as potential species for aquaculture in the Amazon Basin. The Peru Project is also supporting activities in the Workplans of collaborating institutions and projects, such as those investigating soil-water interactions and socio-economics.

METHODS AND MATERIALS

Objective 1. Provide extension services to the local community to promote sustainable aquaculture in the Peruvian Amazon.

Workshops were provided to existing and prospective fish farmers in the Iquitos region. A Spanish-language production manual for *Colossoma* and *Piaractus* was developed to accompany the reproduction manual completed in Workplan 9. These companion manuals were used in workshops conducted at the IIAP Quistococha Aquaculture Station for teaching prospective farmers the basics for pond culture. A video displaying standard practices for spawning and culturing *Colossoma* and *Piaractus* was also produced to complement the written manuals. Two international workshops were conducted for farmers currently producing fish. One workshop was conducted for prospective fish farmers in the region, identified from the many inquiries made to IIAP for general information on fish farming. This workshop was more general in nature and served as a primer for the more advanced workshop, which was provided to existing producers. All workshops included orientation on the business aspects of aquaculture.

Bi-monthly site visits were made to fish farms in the Iquitos area. Farms were visited on a rotational basis so that every farm was visited at least once each quarter. Farmers were provided with information on fish husbandry and pond maintenance, and on new findings from our research activities. Standard water quality parameters (temperature, dissolved oxygen, pH, hardness, alkalinity, carbon dioxide, total am-

monia nitrogen, and nitrite) were measured at representative farms throughout the region.

To assess the quality of extension services provided and to obtain suggestions on how to improve the program, producers were surveyed through a questionnaire. The extensionists administered the questionnaire to all clientele receiving their services.

Objective 2. Conduct demonstration projects with local fish farmers to expose them to new species and/or techniques.

Two techniques were utilized to provide technical assistance in aquaculture techniques to local and prospective fish farmers. The techniques consisted of training and certification of "Master Aquaculturists" and on-farm research and demonstration projects.

Four experienced producers were selected for certification as "Master Aquaculturists." CRSP personnel worked intensively with these producers to enhance their techniques and production efficiency. Once these farmers reached satisfactory levels, they were certified as "Master Aquaculturists" and began serving as mentors for novice farmers. The CRSP personnel arranged farm tours of these facilities, which essentially served as living laboratories.

The second technique analyzed the feasibility of transferring technology to area fish farmers by conducting on-farm research and demonstration projects. The effectiveness of this model was ascertained through a preliminary density study with *Arapaima gigas* that was designed and carried out at five local fish farms over a 12-month period. The food source was nuisance fish invaders. An UNAP undergraduate student conducted this study as a component of their thesis work.

Objective 3. Provide short courses to governmental and NGO personnel to develop a network of aquaculture extensionists in Peru and neighboring countries.

Two intensive training courses for small groups of governmental and non-governmental personnel conducting aquaculture research and/or extension activities in the Amazon Basin were offered at IIAP, Iquitos, Peru. For each course, five qualified Latin-American participants were invited to participate. The first course trained aquaculturists in the extension techniques being successfully carried out by IIAP and Terra Nuova staff. This course consisted of three days of lectures and one day of practical fieldwork. The second course was designed for extension personnel with little or no training in aquaculture. Extension personnel learned broodstock selection and handling, spawning techniques, incubation, larviculture, growout, and disease prevention—all specifically related to the species of *Colossoma* and *Piaractus*. This intensive module covered three days of lectures and one day of practical laboratory work where hormone injection, spawning, fertilization, incubation, and larviculture techniques were demonstrated.

Objective 4. Establish a specialized website on Amazonian aquaculture and species to provide for information exchange and networking.

A website on Amazonian aquaculture and species was designed to allow for information exchange and networking. The

website contains information on all CRSP-sponsored research and outreach activities in the Amazon region, and provides links to other agencies active in the region, such as USAID, FAO, World Wildlife Fund, etc. A chat room allows for discussions on Amazonian aquaculture and species by interested participants. The website contains a specialized bibliography on publications on research and outreach activities related to Amazonian aquaculture and species. An up-to-date list of announcements concerning related workshops and meetings is maintained on the site. A list-serve was established and is maintained for the purpose of relaying relevant information on Amazonian aquaculture and species. The number of hits to the site was enumerated to assess the site's exposure.

RESULTS

Objective 1. Provide extension services to the local community to promote sustainable aquaculture in the Peruvian Amazon.

Since February 1, 2002, two CRSP/IIAP extensionists have been conducting visits twice monthly to 80 producers selected among the more than 250 producers along the Iquitos-Nauta Road. Some of the producers not selected still regularly received technical assistance by contacting the extensionists at the IIAP Quistococha Aquaculture Station. Additionally, 321 vocational students, eight teachers and 79 university (undergraduate) students took part in aquaculture training courses (one to three days) that contained both theoretical and practical work. These training activities included the following institutions: The Agrarian Technical School "El Milagro" in Iquitos (57 students, three teachers); Agrarian University "La Molina" in Lima (25 pre-professional students); Center for the Formation of Bilingual Indigenous Teachers (35 students and one teacher; all from the following indigenous communities: Cocama, Achuar, Tikuna, Shiwilu, Shapra, Quichua, and Kandozi); Superior Technological Institute "Pedro A. Del Aguila Hidalgo" (57 students and one teacher); Superior Technological Institute of Loreto (172 students); and Faculty of Agronomy, Universidad Nacional de la Amazonia Peruana held at IIAP, Iquitos (54 students and three teachers). Additionally, the impact of the outreach is expanding to the Tigre River region (Santa Helena and Huayococha); for example: Luciano C. Rodriguez visited Huayococha (Manchuria, Bélgica, Tres Bocas, Huacachina Tigre River communities) on 2–7 November 2002 to inspect the floating cages operation, to provide some medicines and basic school supplies and to give a short (one day) training course in basic aquaculture. *Piaractus* and *Colossoma* are still being harvested (30–35 cm mean TL) in the oxbow lake where Terra Nuova and IIAP previously stocked 20,000 fingerlings.

Carlos V. Chavez visited Santa Helena (Tigre River community) to inspect the floating cages operation, to provide some medicines and basic school supplies and to give a short (one day) training course in basic aquaculture. Eleven out of 17 floating cages are currently in operation and *Piaractus* were found to outperform *Colossoma* (1.9 kg vs. 1.6 kg mean weights). *Colossoma* is still being harvested in the oxbow lake where Terra Nuova and IIAP had stocked 16,000 fingerlings in 2001. The school supplies were given to 50 local school children.

A survey was administered to 50 producers. The majority of the producers surveyed (37%) were between the ages of 45–54 and predominantly male (86%). Thirty-three percent have lived

on their farm for more than 20 years and 30% have five or more dependents in the household. Most of the producers (57%) are from Iquitos. Many farms (36%) are greater than 30 ha in size and the ponds are irregular in size with clay soils. For 65% of the ponds, a spring is the primary source of water. Many of the farmers raise multiple crops, such as yucca, plantain, avocado, hens, and ducks in conjunction with fish production. The majority of fish cultured include *Colossoma* (21%), *Piaractus* (18%) and boquichico (*Brycon nigricans*) (25%). Only 16% of producers feed a balanced diet while 28% feed fruits. Twenty-four percent responded that fish generate more profit than chickens or vegetables. Approximately 94% responded that it was advantageous having a fish pond; 98% indicated it was compatible with other household activities; and 98% indicated that fish ponds are a better alternative land usage for their farm. Profitability is the most important factor in fish culture to 43% of producers surveyed and poaching was the greatest threat to 54%. The value of the extensionists is supported by the fact that 98% of the producers have contacted the extensionists in the last six months. Support included technical assistance, tools, fish, lime, feed, and money.

Objective 2. Conduct demonstration projects with local fish farmers to expose them to new species and/or techniques.

Four experienced producers were selected for one-on-one training for certification as "Master Aquaculturists." After receiving individual guidance from the two extensionists for eight months, the four individuals were awarded certification in November 2002, at a public ceremony in Iquitos in the Loreto Aquaculture Association facility. Approximately 40 producers were in attendance and all were invited to visit their farms to learn from their successes.

The on-farm research and demonstration projects were successfully executed with producers along the Iquitos-Nauta Road. The extensionists evaluated the usage of agriculture products to feed *Piaractus* and *Colossoma* by regularly sampling ponds to monitor fish growth. Additionally, a preliminary density study with paiche (*Arapaima gigas*) was carried out in the ponds of five local fish farms over an eight-month period. These five producers had demonstrated excellent culture practices for the production of *Colossoma*, *Piaractus*, and boquichico in previous years. Each producer received six juvenile paiche fingerlings (mean total lengths of 32 to 34 cm and weights of 190 to 325 g) to cultivate in their ponds using a polyculture predator-prey production scheme. The small-scale producer ponds were fertilized with chicken manure (500 kg ha per month) and, to secure a forage base, initially stocked two to three months prior with bujurqui (*Cichlasoma amazonarum*) and/or mojarra (*Gymnocorimbus thayeri* and *Tetragonopterus* sp.) at stocking densities from 20,000 to 30,000 fish per pond. The ponds had an average surface area of 2,500 m² and mean depths of 0.8 m. The two IIAP-CRSP extensionists monitored performance of the paiche by making periodic visits to the producers to assess fish growth, health, survival, and yield. Over the course of approximately one year, paiche grew from 0.3 kg to 7 to 11 kg and had 100% survival (Table 1). The daily growth rates obtained, ranging from 19 to 34 g per day, verify that paiche are one of the world's fastest growing freshwater fish.

Objective 3. Provide short courses to governmental and NGO personnel to develop a network of aquaculture extensionists in Peru and neighboring countries.

Two international training courses (25–30 March and 25–30 August 2002) titled 'Aquaculture of Amazon Species for Extensionists and Producers' were held at IIAP (Quistococha-Iquitos, Peru). Forty participants from the following institutions and organizations attended: 31 Peruvian participants from a variety of agencies and private concerns (FONDEPES, Social Base Organizations, IIAP, Ministry of Fisheries, and the private sector—indigenous fisherman from Quechua, Shipibo, and Cocama communities, fish producers, and businessman); one Bolivian participant from Universidad Mayor de San Simon, Cochabamba; two Brazilian participants (one from INPA and one from Universidad Federal do Amazonas); three Ecuadorian participants (one from Peace Corps and two from the Sarayuku indigenous community); and three Colombian participants (an aquarium fisherwoman, one from Sinchi and one from Universidad Nacional de Colombia). The information provided in the workshops was well received and appreciated by the participants. All indicated they learned a great deal about aquaculture and would be able to incorporate the information in their professional careers or at their farms.

Table 1. Performance of the *Arapaima. gigas* cultured by small-scale fish producers in ponds along the Iquitos-Nauta Road, Peru.

Variable	Producer				
	1	2	3	4	5
Culture Period (mo)	12.5	12.0	11.6	11.0	12.0
Initial Length (cm)	34.0	33.0	32.0	32.0	31.0
Initial Weight (g)	325.0	324.0	325.0	190.0	214.0
Length (cm)	100.0	96.0	92.0	98.0	110.0
Weight (kg)	11.01	7.12	8.45	11.25	11.00
Growth (g d ⁻¹)	28.42	18.88	23.21	33.91	29.55
Survival (%)	100	100	100	100	100
K	1.11	0.80	1.09	1.19	0.82

Objective 4. Establish a specialized website on Amazonian aquaculture and species to provide for information exchange and networking.

The chat room idea changed to a more efficient system called the Amazon AquaForum (Celedith), which was added in early August 2002 to the Amazon website. This Aqua-Forum has been allowing users to formulate questions, which can be readily answered by other users sharing the same area of knowledge. Since 4 September 2002, the website has been visited 1821 times based on hits recorded by iSurfstats, a log file analyzer (V.6.0, 2000). Aquaculturists from the following countries (in descending order of hits) have visited the site: Brazil, Spain, Austria, Mexico, Switzerland, Canada, Germany, Sweden, Denmark, Dominican Republic, Chile, United States, France, Italy, Colombia, Peru, Saudi Arabia, Norway, Hungary, United Kingdom, Portugal, Ukraine, Venezuela, Croatia, Netherlands, Japan, Finland, Czech Republic, Belgium, Argentina, Poland, Greece, Singapore, and Trinidad/Tobago.

DISCUSSION

The two extensionists provided considerable technical assistance to inhabitants along the Iquitos-Nauta Road and

throughout several remote regions of the Peruvian Amazon. Moreover, several bilingual indigenous teachers were provided with training to enable them to provide ongoing assistance to ensure sustainable aquaculture development beyond the life of the Aquaculture CRSP. The survey given to the producers has been of great importance by assessing the value of the extension services provided and delineating areas in which further technical assistance is required.

The international training courses have opened the channels to initiate a network of aquaculturists in the Amazon region. Some of these aquaculturists have now gained expertise to more fully function in extension activities. For example, the Peace Corps participant from Ecuador, who previously knew little about aquatic animal production, is now about to construct an Amazon species fish hatchery for an indigenous community in Ecuador. Likewise, the website has received an ample array of visitors from countries not only from the Amazon region, but from throughout the world. This website has allowed several researchers to contact us directly with questions and to provide suggestions on how to develop aquaculture of native species in the Amazon region and elsewhere.

In general, *A. gigas* exhibited excellent growth and survival in the on-farm trials. The observed growth rate was similar to that reported by Imbiriba et al. (1996) and surpassed the mean weight (3.7 g) reported by Alcántara and Guerra (1992) using the same cultivation procedures. The values of condition factor (k) are smaller than those reported by Berger (1972) in studies carried out in natural populations with a total length (TL) from 110 to 250 cm and 10 to 189 kg in weight, which could be associated with age factors of the fish. The length and weight reached by pond-raised *A. gigas* in almost one year compared favorably to that reported by Berger (1972) in natural populations in the Pacaya Samiria National Reserve (Peru). Further, the same author indicated that the *A. gigas* indiscriminate fishery in this reserve from 1959 to 1969 affected the wild *Arapaima* population. Thus, the length achieved by the cultured *A. gigas* is consistent with the minimum 160 cm TL capture size imposed by the Peruvian Ministry of Fisheries (Resolution 147-2001-PE), which should be enforced to improve the management of this important resource.

CONCLUSIONS

The extension services provided to producers along the Iquitos-Nauta Road and in several remote areas of the Peruvian Amazon have been highly beneficial. Moreover, by training a number of bilingual indigenous teachers to provide continuous aquaculture extension, we have ensured these benefit will continue to accrue, at least at a modest level, well beyond the life of the Aquaculture CRSP. The results of the producer survey identified the critical areas for technical assistance most needed and will be used as a guide for the extension services to be offered in Workplan 11.

The preliminary results obtained with *Arapaima gigas* suggest the species is a good candidate for aquaculture because of its excellent survival, fast growth rate, and its reproduction in captivity. In addition, the Peruvian small-scale producers indicate high satisfaction with performance obtained to date and have expressed a strong desire to continue with this practice. However, government regulations (Peruvian Ministry of Fisheries) will need to consider a revision regarding the constraint

of having to obtain permits for the production of *A. gigas* in enclosed environments, both for culture and fingerling production, before *A. gigas* culture can become widespread.

The international training courses served to open communication channels to initiate a network of aquaculturists in the Amazon region. The website has become an important tool to communicate aquaculture research being conducted by institutions in the USA, Amazon nations, and elsewhere.

ANTICIPATED BENEFITS

Aquaculture is an alternative form of agriculture offering significant benefits to rural residents and farmers throughout the Peruvian Amazon. Aquaculture requires considerably less land than that needed for cattle ranching, and ponds can be used year after year whereas rainforest lands converted to traditional agricultural practices are rarely productive for more than a couple of seasons. Such lands, once abandoned, usually can no longer support normal jungle growth. Aquaculture will benefit both rural and urban poor through the addition of a steady supply of high quality protein in the marketplace.

Workplan 10 investigated key aspects of nutritional requirements, reproduction biology and ecological significance of several Amazonian freshwater fish species, in particular, *C. macropomum* and *P. brachypomus*, in order to improve or develop sustainable aquaculture technology. *Colossoma* and *Piaractus* have been suggested to play a crucial ecological role in disseminating seeds from the flooded forest (Goulding, 1980; Araujo-Lima and Goulding, 1997). Accordingly, the aquaculture of *Colossoma* and *Piaractus* may be ecologically as well as economically and nutritionally beneficial to the inhabitants of the Peruvian Amazon. Enhanced spawning performance as a result of improved nutrition of the broodstock of two important food fishes in the Peruvian Amazon, *Colossoma macropomum* and *Piaractus brachypomus* is an anticipated outcome of the research. Development of the technology of intensive growth of these species and stocking four to six weeks old juveniles will dramatically increase their survival and efficiency of production. The first beneficiaries of this research will be the local producers of *Colossoma* and *Piaractus* species in the Peruvian Amazon. Aquaculture of these species should relieve

some of the fishing pressure on these over-harvested, native species.

This study contributed toward capacity strengthening by providing training for IIAP staff on various aspects of fish nutrition and reproduction. Results of the training include:

1. 40 extensionists were trained in latest techniques developed through CRSP research.
2. 80 fish farmers received extension services.
3. 1,821 hits from 35 countries occurred on the Amazonian aquaculture website.

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