



AQUACULTURE CRSP 22ND ANNUAL TECHNICAL REPORT

AMAZON AQUACULTURE OUTREACH

*Eleventh Work Plan, Sustainable Development and Food Security Research 1 (11SDFR1)
Final Report*

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ABSTRACT

Outreach activities significantly benefited over 150 producers and their families (346 ponds, 110 ha.) in the Peruvian Amazon. The certification of six master aquaculturists and on-farm research activities helped provide technical assistance in aquaculture techniques to local and prospective fish farmers. The on-farm research activities, conducted with four local fish farmers, were part of an undergraduate thesis project on species diversification. Several aquarium fish species (*Osteoglossum bicirrhosum*, *Astronotus ocellatus*, and *Cichla monoculus*), also consumed in some local markets, were found to be suitable for culture. The two CRSP-funded extensionists provided aquaculture training to 777 vocational, high school, and university students in the Amazon Basin (Brazil, Colombia, Ecuador, and Peru). Sixty-two individuals representing Ecuador, Bolivia, Brazil, Colombia, Venezuela, and Peru participated in aquaculture short courses. The Amazonian aquaculture website, developed during the Tenth Work Plan, was expanded. This website is an important tool to communicate the work done by research institutions in the US, many Amazon nations, and elsewhere (over 6,000 hits from 1 May 2003 through 31 May 2004).

INTRODUCTION

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

In the Peruvian Amazon, four major institutions are working with aquaculture: Instituto de Investigaciones de la Amazonia Peruana (IIAP), Fondo Nacional de Desarrollo Pesquero (FONDEPES), Ministerio de Pesquería (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 (Alcántara and Guerra, 1992). However, considerable potential exist to examine other species, as the Amazon Basin is home to over 2,000 freshwater species of fish. A Memorandum of Understanding is currently in place linking IIAP, UNAP, and 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 pond water quality parameters and conduct pertinent research on sustainable aquaculture development of important fish species native to South America. These facilities at IIAP have been significantly upgraded/renovated during the Ninth and Tenth Work Plans.

Activities of the Tenth Workplan greatly facilitated the establishment of Peru as a full-fledged prime site for Aquaculture CRSP activities and research. For the Aquaculture CRSP Eleventh Work Plan, three projects were funded: 1) Amazon Aquaculture Outreach, 2) Nutrition of *Colossoma macropomum* and *Piaractus brachypomus*, and 3) Studies on Larval Rearing of Amazonian Fish. These projects are extensions of research and outreach activities first developed during the Ninth Work Plan. Outreach and networking activities were undertaken to facilitate regionalizing the benefits of the CRSP. IIAP efforts have concentrated on larval rearing, nutrition and development of growout diets (both prepared feeds and plant products for growout) for *C. macropomum* and/or *P. brachypomus*.

METHODS AND MATERIALS

Objective 1. Provide extension services to the community to promote sustainable aquaculture in the Amazonian region.

Two CRSP-funded extensionists continued to reinforce extension activities with fish producers along the road system between the cities of Iquitos and Nauta, as well as along the Nanay (Padrecocha), Itaya (12 de Abril) and Marañón (Nauta) Rivers. These farms (151) 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 for a diversity of novel endemic species (*Arapaima gigas*, *Prochilodus nigricans*, *Brycon erythropterus*, *Osteoglossum biscirasum*, *Cichlasoma amazonarum*- as a forage fish,) in addition to the species that they have traditionally been cultivating (*P. brachypomus* and *C. macropomum*). General pond maintenance, as well as with any new developments learned through

research activities, were covered. Standard water quality parameters (temperature, dissolved oxygen, pH, hardness, alkalinity, carbon dioxide, total ammonia nitrogen, and nitrite) and fish weight and length were measured at representative farms throughout the region as part of a follow-up program. The Spanish-language production manual for *Colossoma* and *Piaractus* compiled by the Tenth Work Plan was updated.

One of the extensionists, transferred to the Amazon City of Pucallpa, returned to Iquitos because of public security risks in that city. Extension services were expanded to other countries in the Amazon region (Ecuador, Colombia, and Brazil). Short training courses to a diversity of ethnic groups (Quichua) occurred and a new aquaculture association (ACUIAMAZONAS with 50 members in Leticia, Colombia) was formed in the Amazon region. A scheduled visit to Bolivia was cancelled due to the sociopolitical uprising in the cities of Cochabamba and Santa Cruz.

Producers were surveyed through a questionnaire to assess quality of extension provided and to obtain suggestions on how to improve the program. The extensionists administered the questionnaire to the producers during the certification ceremony of the Master Aquaculturists.

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

In the Tenth Work Plan, two successful producers were trained as Master Aquaculturists; in the Eleventh Work Plan, six producers were trained. CRSP extensionists worked intensively with these producers to enhance their techniques and production efficiency. The Master Aquaculturists were then asked to serve as mentors and instructor for other producers.

Technology was transferred to area fish farmers through on-farm research and demonstration projects. The on-farm research was designed and conducted as part of a UNAP undergraduate student's thesis project on species diversification. The project was conducted with five local fish farmers over a seven-month period culturing some highly priced aquarium and food fish species (*Osteoglossum bicirrhosum*, *Astronotus ocellatus*, and *Cichla monoculus*). This student also received extension training, together with three other UNAP undergraduate students.

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

Two intensive training courses were offered at Pucallpa (Peru) for governmental (military personnel included), non-governmental personnel, and students conducting aquaculture activities in the Amazon Basin. The first

course, consisting of three days of lectures and one day of practical laboratory work, trained potential producers and apprentice aquaculturists on the production of some prominent native species. The second one-day course was exclusively on fish nutrition and utilized aquaculturists and students with some aquaculture training. A CD-ROM displaying all the course material for the Amazon aquaculture-training course was produced.

Objective 4. Develop an exchange program for researchers, extensionists and students in the Amazon region.

An exchange program was initiated for six students from participating universities from the Amazon region (Peru and Brazil). The students were given the option of conducting thesis work (3 to 6 months), short site visits (1–8 weeks) to the aquaculture installations of neighboring countries, or to participate in seminars, workshops and symposiums covering Amazon aquaculture related topics. Additionally, the two CRSP extensionists participated in several site visits and community training in Ecuador, Colombia, and Brazil.

Objective 5. Maintain and expand the specialized website on Amazonian aquaculture and species to provide for information exchange and networking.

A website (<http://ws1.coopfish.siu.edu/amazonia/index.html>) on Amazonian aquaculture and species was expanded to allow for information exchange and networking. This website contains information on all CRSP-sponsored research and outreach activities in the Amazon region. It also provides links to other agency activities in the region such as USAID, World Wildlife Fund, etc. An "AquaForum" allows for discussions on Amazonian aquaculture and species by interested participants. The website also contains a specialized bibliography on research and outreach publications 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 (Domeus) and maintained for the purpose of relaying relevant information on Amazonian aquaculture and species. The number of hits to the site has been enumerated to determine the site's exposure.

RESULTS

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

Since 1 May 2003, two CRSP/IIAP extensionists conducted monthly visits to 151 producers (299 ponds – 110 ha.) selected among the more than 320 producers (253 ha. of total pond surface) along the Iquitos-Nauta Road. Producers not visited monthly received technical assis-

tance by contacting the extensionists at the IIAP Quistococha Aquaculture Station. Additionally, 777 university, vocational, and high school students took part in one to two day aquaculture training courses that contained theoretical and/or practical work. These training activities included the following institutions:

1. Instituto Superior Tecnológico Pedro A. Hidalgo: Fish Culture Course given to 17 students (6 females/11 males) at their own culture facility (1 pond-2,400 m², near Iquitos, Peru).
2. Instituto Superior Pedagógico de Loreto: Fish Culture Course given to 88 students (38 females/50 males) (Iquitos, Peru).
3. Colegio Agropecuario El Milagro Km 22: Two Fish Culture Course given to 83 students (16 females/67 males) (Iquitos, Peru).
4. Colegio Variante Agropecuario 13 de Febrero km 33: Fish Culture Course given to 29 students (10 females/19 males) (Iquitos, Peru).
5. Colegio Secundario Mariscal Oscar R. Benavides: Fish Culture Course given to 76 students (13 females/63 males) (Iquitos, Peru).
6. Facultad de Agronomía – UNAP: Fish Culture Course given to 57 students (13 females/44 males) and 2 teachers (Iquitos, Peru).
7. Facultad de Ciencias Biológicas – UNAP: practical training for a UNAP Fish Culture Course given to 55 university students (28 females/27 males) (Iquitos, Peru).
8. Facultad de Ciencias Alimentarias – UNAP: guided visit for 19 university students (8 females/11 males) (Iquitos, Peru).
9. Centro de Formación de maestros Bilingües: 19 students (2 females/17 males) from the following indigenous communities: Cocama, Achuar, Tikuna, Shiwilu, Shapra, Quichua, and Kandozi (Iquitos, Peru).
10. Parque Ecológico de Quistococha: Two training courses on aquaculture techniques to the 52 employees (7 females/45 males) (Iquitos, Peru).
11. IIAP Quistococha: CRSP extensionists collaborated in the training of the 18 participants (3 females/15 males) from a diversity of ethnic groups: Boras, Aguaruna, Huambisa, Domingusa-Kuith, and Copal-Urco) from the Peruvian Amazon for the “Aquaculture and Animal Production Training Course for Indigenous Extensionists” held on Nov. 2003. (Iquitos, Peru).
12. Colegio Comunidad Sarayaku: Introduction to aquaculture course by Carlos Chavez (CRSP Extensionist) to 84 participants (64 high school indigenous students - 20 females/44 males, 2 teachers and 18 parents) (Rio Pastaza, Ecuador).
13. Colegio Amazonas de San Juan Bosco: talk given by Carlos Chavez (CRSP Extensionist) to 5 school administrators (2 males/3 females) assisted by a Peace Corp volunteer Lee Sherril (Morona Santiago, Ecuador).
14. ACUIAMAZONAS: introductory course on aquaculture by Carlos Chavez (CRSP Extensionist) to 50 association members along the Leticia-Tarapacá road (Leticia, Colombia).
15. Universidade Federal do Estado do Amazonas: Maria Aldea (CRSP Extensionist) participated as a spokes person in the 1st Workshop of the Pira’sem project with 85 participants (63 males/22 females) from Sateré-Mawé indigenous community (Manaos, Brazil).
16. Universidade Federal do Estado do Amazonas, Faculdade de Ciências Agrárias – Departamento de Ciências Pesqueiras: Presentation by Maria Aldea (CRSP Extensionist) on extension techniques to 38 students (14 females/24 males) (Manaos, Brazil).
17. The Spanish-language production manual for *Colossoma* and *Piaractus* produced in the Tenth Work Plan was updated with some new illustrations and concepts generated by the research conducted under CRSP sponsorship. This manual is being distributed to IIAP Quistococha workshop and training course participants and to a diversity of institutions in the Peruvian Amazon, as well as to other countries in the Amazon region (Ecuador, Colombia and Brazil).

The producer survey identified these concerns or limitations:

- 1) Frequency of technical visits: In the Iquitos area, only 151 out of 320 producers received services. It is not possible to cover all producers with only 2 extensionists, a labor that took 5 extensionists during the initial program by Terra Nuova (Italian NGO).
- 2) Fingerling availability: There is a void in the supply of fingerlings particularly in the regions of the Amazon Basin. IIAP is expanding its fingerling production capability, by increasing the survival of the fingerlings and the number of broodstock available for reproduction.
- 3) Permitting: Permits to cultivate ornamental fish and species like *Arapaima gigas* are high. The Ministry of Fisheries is being contacted concerning a solution.

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

Six experienced producers were selected for one-on-one training for certification as Master Aquaculturists. After receiving individual guidance from the two extensionists for ten months, the six individuals were awarded certification in April 2004 at a public ceremony in Iquitos in the Loreto Aquaculture Association facility. Approximately 60 producers were in attendance and all were invited to visit their farms to learn from their successes.

The Master Aquaculturists trained and certified during the Eleventh Work Plan are:

- 1) Erwin Fernandez Delgado,
- 2) David Vela Gomez,
- 3) Jakeline Reategui Peña,
- 4) Manuel Perez Vallejos,
- 5) Pedro Noriega, and
- 6) Ilmer Murrieta de Panduro

On-farm research was conducted with five producers along the Iquitos-Nauta Road. CRSP extensionists, an undergraduate UNAP Biology student (Percy Mejía Poquioma), and three UNAP Fish Culture students (Nadia M.J. Lingan Gonzalez, Evelyn Miura Shibao, and Grace Montalván Naranjos) participated. Some highly priced double-purpose aquarium and food fish species (*Osteoglossum bicirrhosum*, *Astronotus ocellatus*, and *Cichla monoculus*) were evaluated over a seven-month period (August 2003–February 2004). The following producers participated:

1. Walter Torres Reategui, Nauta, cultured arawanas (*Osteoglossum bicirrhosum*) in a 16,000 m² pond.
2. Pedro Mozombite Estrella, Quistococha, cultured tucunare (*Cichla monoculus*) in a 4,200 m² pond.
3. Juan Davila, San Pablo de Cuyana, stocked 1,000 acarahuazu (*Astronotus ocellatus*) in two, 1,000 m² ponds.
4. Luis Cardozo Sanda, Villa del Buen Pastor, stocked 1,000 acarahuazu (*Astronotus ocellatus*) in two, 1,000 m² ponds.
5. Miguel Hernán Cabrera Ayapi, Villa del Buen Pastor, stocked 5,000 tucunare (*Cichla monoculus*) in two, 3,200 m² ponds.

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

The first course, “III Curso Internacional de Acuacultura Con Especies Promisorias de la Amazonia” (18–21 August 2003) trained potential producers and apprentice aquaculturists on the production of prominent native species. Participants included two Bolivians from the Universidad Mayor de San Simon; one Brazilian from the Universidad Federal do Amazonas; one Ecuadorian from Colegio de San Juan Bosco; one Venezuelan from the Instituto Limnológico, Universidad de Oriente; and two Colombians from the Secretaría de Agricultura and Parque Nacional Natural Isla de Salamanca. This course consisted of three days of lectures, one day of practical laboratory work where hormone injection, spawning, fertilization, incubation, and larviculture techniques were demonstrated, and a half day visit to the Ucayali Aquaculture Navy Production and Training Facility. The second course, “I Curso Internacional de Nutrición de Peces Tropicales” (22 August 2003) was taught by Wil-

liam Camargo (SIUC) and Rebecca Lochmann (University of Arkansas Pine Bluff). This course emphasized fish nutrition and covered the following topics: physiological aspects of reproductive apparatus and nutritional requirements of the larvae; advantages of live food vs. balance diets in larvae culture; description of live food groups, proteins and amino acids; lipids and fatty acids; diet total energy; vitamins and minerals; diets preparation; and feeding strategies. A CD-ROM displaying all the course material for the Amazon aquaculture-training course was produced to complement the written manuals.

The evaluation indicated that 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 operations.

Objective 4. Develop an exchange program for researchers, extensionists and students in the Amazon region.

The exchange program successfully integrated participating countries from the Amazon Region. Six undergraduate students (4 females/2 males) from Peru (Iquitos) and Brazil (Manaos) participated. As a result of the exchange, three participants initiate contacts to start post-graduate studies in Manaos, Brazil. Their names and research topics follow.

1. Jimmy Carlos Campos Cedano (Universidad Nacional de la Amazonia Peruana, Iquitos) Title: Efecto de la densidad de siembra en el crecimiento de *Colossoma macropomum* “tambaqui” en jaulas en tanque jaulas flotantes durante el durante el 1^{er} mes de engorde”. Duration: 75 days in EMBRAPA.
2. Melyna Silva Pezo (Universidad Nacional de la Amazonia Peruana, Iquitos), Reproductive Biology of *Cichlasoma* sp. in Controlled Environments. Duration: 30 days in UFAM.
3. Adela Ruiz (Universidad Nacional de la Amazonia Peruana, Iquitos), Technology on *Arapaima gigas* Culture in Floating Cages. Duration: 60 days in INPA.
4. Luis Javier Velásquez (Universidad Nacional de la Amazonia Peruana, Iquitos), Duration: 30 days in INPA.
5. Otto Rafael Zumaeta Pinedo (Universidad Nacional de la Amazonia Peruana, Iquitos), Selectividad Zooplanctónica por alevinos de “paco” *Piaractus brachyomus* (Cuvier, 1818) en un estanque. Duration: 70 days in EMBRAPA.
6. Elene Maciel Braga (Universidad Federal Do Amazonas, Manaos), Training on culture and reproduction of prominent native fish and mollusk Amazon species, and live food production. Duration: 30 Days in IAP.

Additionally, both CRSP extensionists conducted site visits and community training in Ecuador (12 day visit by Carlos Chavez V. to Sarayaku indigenous community and San Juan Bosco community), Colombia (1 week visit by Carlos Chavez V. to Leticia-Tarapacá) and Brazil (4 week visit by Maria Aldea G. to Manaus, and several indigenous communities near Manaus, and by Carlos Chavez V. to Tabatinga and Benjamin Constant).

Objective 5. Maintain and expand the specialized website on Amazonian aquaculture and species to provide for information exchange and networking. (10NSR1).

Amazon Aqua Forum (Domeus), added in July 2003 to the Amazon website, allows users to formulate questions to other users. From 1 May 2003 through 31 May 2004, there were 6,320 hits (SurfstatsV.6.0, 2000). Based on registered Domain names, the following countries have visited the site: Brazil, Switzerland, Colombia, Sweden, Peru, Germany, Portugal, Mexico, Spain, Norway, U.K., Taiwan, Austria, Belgium, USA, Japan, Australia, Chile, Canada, Argentina, and Hungary.

DISCUSSION

The two CRSP-funded extensionists provided considerable technical assistance to inhabitants of the Amazon Basin, particularly in Brazil, Colombia, Ecuador, and Peru. Several bilingual indigenous teachers were trained to enable them to provide ongoing assistance to ensure sustainable aquaculture development beyond the life of the Aquaculture CRSP. The producer survey was valuable in assessing the value of the extension services provided and delineating areas where further technical assistance is required.

The International training courses opened the channels to initiate a network of aquaculturists in the Amazon Basin. Some of these aquaculturists gained expertise to more fully function in extension or production activities. For example, the Peace Corps participant from Ecuador, with little previous knowledge about aquatic animal production, constructed an Amazon species fish hatchery for an indigenous community in Ecuador and a hatchery to provide fingerlings for the Sarayaku indigenous community is under construction. The exchange program for students, extensionists and professionals provided a valuable opportunity to exchange practical knowledge.

The on-farm research diversification study had some limitations because of government permit regulations. Permit regulations must change to allow farmers to obtain ornamental fish culture permits with lower fees. Additionally, low prices paid by the local aquarium trade for the fish produced in ponds compared to the prices that they get from their overseas intermediaries, has hindered the development of this diversification pro-

gram. This may change with the possible ban as of 2005 on exporting wild caught ornamental fish.

Finally, the expanded website received an ample array of visitors from countries in the Amazon region and throughout the world. This website was used by researchers to exchange questions and answers with CRSP researchers pertaining to the aquaculture of native species in the Amazon region and elsewhere.

CONCLUSIONS

The extension services provided to aquaculture producers of the Amazon Basin have been highly beneficial. 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 need to obtain more frequent visits by the two extensionists, which was the principal critical area for technical assistance most cited and will be used as a guide to improve extension services offered in the Twelfth Work Plan.

Results from the on-farm research on species diversity with ornamental and food fish species suggest that this culture scheme is feasible, although marketing strategies are required to find direct outlets.

The International training courses served to open communication channels to initiate a network of aquaculturists in the Amazon region. The exchange program for students, extensionists and professionals has provided a very dynamic channel to exchange practical knowledge.

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 needed for cattle ranching. 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. Aquaculture will benefit both rural and urban poor through the addition of a steady supply of high quality protein in the marketplace.

The Eleventh Work Plan investigated key nutritional requirements and ecological significance of several Amazonian freshwater fish species, *C. macropomum* and *P. brachypomus*, to improve and 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 Amazon region. The first beneficiaries of this research will be the local producers of *Colossoma* and *Piaractus* species in the Amazon Basin. Aquaculture of these species should relieve some of the fishing pressure on these over-harvested, native species.

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

- 1) 62 producers and university students were trained through two international training courses on the latest techniques developed through CRSP research;
- 2) 6 countries from the Amazon Basin received direct benefits through the training of participating students, professionals and farmers;
- 3) 777 high school, technical level, and university students from a diversity of ethnical groups and nationalities were trained in aquaculture concepts;
- 4) 151 fish farmers (299 ponds – 110 ha.) received extension services; and
- 5) 6,320 hits from 26 countries and groups occurred on the Amazonian aquaculture website.

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