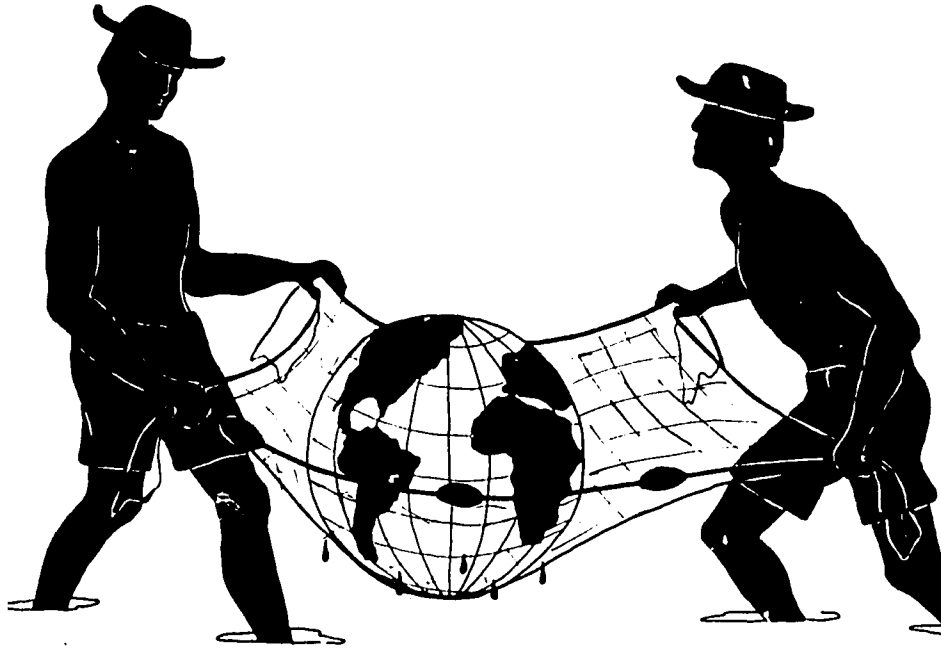
TITLE XII
COLLABORATIVE RESEARCH SUPPORT PROGRAM

POND DYNAMICS/AQUACULTURE



Pond Dynamics/Aquaculture CRSP
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THIRD ANNUAL ADMINISTRATIVE REPORT

December 1985

This administrative report addresses the management and technical accomplishments of the Pond Dynamics/Aquaculture CRSP during the reporting period from 1 September 1984 through 31 August 1985. Program activities are funded in part by AID grant No.: DAN-4023-G-SS-2074-00.

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EXECUTIVE SUMMARY

The Pond Dynamics/Aquaculture Collaborative Research Support Program (CRSP) is a coordinated international effort to develop aquacultural technology as a means of confronting food and nutritional problems. The program is partially supported by a U.S. Agency for International Development (AID) grant awarded in August 1982, under the authority of the International Development and Food Assistance Act of 1975 (P.L. 94-161). Oregon State University is the Management Entity for the CRSP and has technical, administrative and fiscal responsibility for the performance of grant provisions.

The Pond Dynamics/Aquaculture CRSP is a cohesive program of collaborative research carried out in selected developing countries by teams of U.S. and Host Country scientists. The U.S. institutions participating in the program are Auburn University, the University of California at Davis, and the Consortium for International Fisheries and Aquaculture Development (CIFAD). CIFAD members include the University of Arkansas at Pine Bluff, the University of Hawaii, the University of Michigan, Michigan State University and Oregon State University. Active CRSP projects involve the participation of government agencies and educational institutions in six Host Countries: Honduras, Indonesia, Panama, the Philippines, Rwanda, and Thailand.

PROGRAM ACCOMPLISHMENTS

The third operational year of the program has been devoted to carrying out the standardized pond dynamics experiments at research stations in six Host Countries, to refining the CRSP research plan, and to accomplishing a comprehensive triennial performance review.

Program Management and Technical Guidance

The program management of the CRSP remained basically the same as reported in previous years with some notable exceptions. The three member Executive Council changed its name to "Board of Directors" to comply with CRSP guidelines. The Board continued to establish program policy and participated in the Triennial Review process to be completed in December 1985. The three member Technical Advisory Committee again had the lead role in the annual research planning process, which was the focus of a four day meeting of U.S. and Host Country participants held in Honolulu, Hawaii March 18-21, 1985.

The CRSP External Evaluation Panel completed their evaluation of the CRSP for the Triennial Review. Visits to project sites and attendance at the Annual Meeting aided the panel in their evaluation.

The Program Management Office, representing the Management Entity for the CRSP grant, continued to facilitate and coordinate research activities and to prepare summary and fiscal reports. This

office issued the following during 1985: the Second Annual Administrative Report; the Third Cycle CRSP Workplan; the External Evaluation Report; the Triennial Review Report; a series of quarterly newsletters, and an updated program directory. Triennial Review activities were coordinated and arranged from this office and the Program Director accompanied by the Board of Directors will attend the final review in Washington D.C. in December. This office has also coordinated the hiring of a Data Synthesis Team to assume responsibilities for implementing a CRSP data base management system.

Research Activities

The CRSP Research Team is a union of the U.S. and Host Country Principal Investigators participating in the program. During the reporting period the Team (with U.S. and Host Country Research Associates at each station) directed its efforts to carry out a series of standardized pond dynamics experiments at Host Country research stations. These involved comparing the physical, chemical and biological responses of ponds stocked with tilapia or marine shrimp receiving organic fertilizers to ponds receiving inorganic fertilizers. Because of disparity in the initial time required to prepare research facilities at the various sites, rates of progress have varied among the projects as summarized below:

The Honduras/Auburn University project team completed the dry season phase of the second cycle of standardized pond dynamics experiments and initiated the wet season phase. Special topic research on the effects of turbidity on fish production has found that organic manures are effective in reducing clay turbidity and that further research regarding the mechanisms is warranted.

The Indonesia/Michigan State University project team completed the dry season phase of the second cycle of standardized pond dynamics experiments and initiated the wet season phase. Poor fish production values were low in the first cycle experiments, possibly due to water contamination from pesticides and detergents. Special topic research in methods of improving the water supply led to the development of a Water Conditioning System which greatly increased alkalinity and therefore fish production. Further research will be conducted.

The Panama/Auburn University brackish-water project team completed both the wet and dry phases of the second cycle of standardized pond dynamics experiments at the marine shrimp research facility in Aguadulce. The third cycle dry season experiments are in progress. Special topic research on comparison of production success of two species of marine shrimp raised either separately or in polyculture was completed. The standardized research program on ponds stocked with tilapia was implemented at the Gualaca site, and a U.S. Research Associate hired. The first cycle dry season experiments have been completed, and the first cycle wet season experiments are in progress.

The Philippines/University of Hawaii project team completed both the wet and dry phases of the second cycle of standardized pond dynamics experiments. The third cycle dry season experiments are in progress. The effect of pond depth on water quality in replicated shrimp ponds with depths of less than one-half meter, one meter and two meters is being compared.

The Rwanda/Oregon State University project team has devoted the second operational year to preparing the facilities at the station in Butare. The first and third cycle of CRSP experiments will be run concurrently and are now underway.

The Thailand/University of Michigan project team completed the dry season phase of the second cycle of pond dynamics experiments at the Ayutthaya station. The wet season phase of the second cycle is in progress. Special topic research on hatchery procedures for spawning, hatching, and rearing sand goby fry was completed.

At the third annual research planning workshop held in Honolulu, Hawaii in March 1985, Host Country and U.S. participants gathered to review technical progress at each project site and to revise the CRSP work plan as appropriate for the third cycle of experiments. Changes were made in the list of variables to be measured, and in some cases, in the sampling and analytical methods to be employed. Evaluation by the External Evaluation Panel was also an important aspect of this meeting, as Panel members met with research teams and administrative personnel to discuss project progress.

STAFF SUMMARY

The Pond Dynamics/Aquaculture CRSP represents the joint efforts of more than 40 professionals, specializing in fields such as research administration, limnology, fisheries, and data management. Of those professionals having a major role in the program, 22 are in residence within the participating Host Countries.

FINANCIAL STATEMENT

A cumulative total of $2,400,000 of AID funds were obligated for CRSP projects and management by the end of this reporting period. Of this total, the Management Entity paid invoices amounting to $2,314,153. Participating U.S. institutions expended a total of $440,015 in non-federal funds in the performance of CRSP activities, meeting the cost sharing requirement specified in the CRSP grant. Although Host Country cost sharing is not required, cumulative contributions by participating Host Country institutions amounting to $829,420 indicate a continuing strong commitment to the program.

1. INTRODUCTION

The Title XII Collaborative Research Support Program (CRSP) in Pond Dynamics and Aquaculture is sanctioned by the U.S. Agency for International Development (AID) and the Title XII Board for Food and Agricultural Development (BIFAD) under the authority of the International Development and Food Assistance Act of 1975 (P.L. 94-161). Through cooperative effort, selected universities in the U.S. and institutions in less developed countries (LDCs) are working to develop aquacultural technology as a means of confronting food and nutritional problems. AID has awarded Collaborative Research Support Grant Number DAN-4023-G-SS-2074-00 to Oregon State University as Management Entity for the CRSP.

The CRSP activities were formally initiated on September 1, 1982. The overall goal of the first operational year was to complete all administrative and technical tasks necessary to initiate field experiments in a number of host country locations. This was accomplished according to a time-phased implementation plan as described in the CRSP grant. Key activities summarized in the First Annual Administrative Report dated December 1983, included:

- Formalization of host country and funding agreements.
- Completion of personnel assignments.
- Development of a detailed experimental protocol for a first cycle of field experiments.
- Establishment of an on-site research staff, preparation for and initiation of experiments at each host country location.

The principal accomplishments during the second operational year, summarized in the Second Annual Administrative Report (December 1984) included:

- Initiation and/or conclusion of the standardized experiments described in the CRSP Work Plan: First Experimental Cycle
- Development of the work plan for the second experimental cycle, including continuation of standardized experiments at all locations and site specific special topics research
- Implementation of the second work plan upon completion of the first cycle
- Establishment of a centralized data base management system

PURPOSE OF THIS REPORT

In accordance with the provisions of the Collaborative Research Support Grant for the Pond Dynamics/Aquaculture CRSP, the purpose of this Third Annual Administrative Report is to summarize program management activities and technical accomplishments during the period from 1 September 1984 through 31 August 1985.

PROGRAM OBJECTIVES DURING THE REPORTING PERIOD

The principal objectives for the third operational year of the CRSP were:

- Initiate and/or complete the standardized experiments described in the CRSP Work Plan: Second Experimental Cycle
- Develop the work plan for the third experimental cycle, including continuation of standardized experiments at all locations and site specific special topics research.
- Implement the third work plan upon completion of the second cycle of experiments.
- Complete program evaluation for the AID Triennial Review

ORGANIZATION OF THIS REPORT

The remainder of this report is presented in three chapters. Chapter 2 summarizes the administrative and technical accomplishments of the third operational year of the program. This chapter includes an overview of organization and management, and project summaries for activities being carried out in six host countries. Chapter 3 summarizes the fields of specialization and work locations of personnel participating in the CRSP. The final chapter of this report is a financial statement, summarizing the CRSP budget and identifying the contributions of U.S. and host country institutions participating in the program.

2. PROGRAM ACCOMPLISHMENTS

While CRSP research has been the dominant theme during this reporting period, other notable accomplishments mark the third year of CRSP operation. All projects are progressing with CRSP second cycle experiments, and U.S. and host country special topic research has been initiated. A data base management system has been implemented, and the program has completed evaluation for the Triennial Review in December.

PROGRAM MANAGEMENT AND TECHNICAL GUIDANCE

The structure and composition of the program management and technical guidance agencies of the CRSP during the reporting period remained basically the same as reported in the Second Annual Administrative Report. The Program Manager and his staff, representing the Management Entity, continued to work with the Board of Directors and the Technical Advisory Committee to guide the CRSP in areas of policy, budget management and technical performance. The CRSP External Evaluation Panel conducted an impartial review of the program and was an essential part of efforts to ensure that CRSP research remains carefully directed and cost effective.

Board of Directors

As the primary policy making body for the CRSP, the Board of Directors has taken an active role in guiding the program toward maturity. The three members, each representing one of the major institutional participants in the program are:

Dr. Alfred Beeton (Chairman) (1982-present)
Director, Great Lakes & Marine Waters Center
University of Michigan

Dr. Wallis H. Clark, Jr (1982-present)
University of California at Davis
Bodega Marine Laboratory

Dr. E. W. Shell (1982-1985)
Auburn University

Dr. Donovan D. Moss (1985-present)
Auburn University

The Board has met quarterly to provide guidance on policy, budgets, and technical performance. Board action has included:

- Advisement of the Management Entity on matters of CRSP policy
- Review of fiscal reports and advisement of the Management Entity regarding the apportionment of the limited funds

available for program activities in the preparation of CRSP budgets.

- Guidance of efforts to strengthen CRSP projects by fostering special topic research at host country sites and at U.S. locations.

- Guidance in the development of a centralized CRSP data management system, including laying the groundwork for appointment of a Data Synthesis Team.

- Review of the performance of the Program Manager

- Evaluation of the administrative and technical accomplishments of six CRSP project teams

- Guidance of efforts to develop a U.S. research component of the CRSP, including identification of critical research needs and approval of proposals funded by the Management Entity.

- Participation in the CRSP Third Annual Meeting in March 1985

- Assistance in planning the CRSP Triennial Review and participation in overseas site visits as part of the review process.

- Review and acceptance of the External Evaluation Panel report.

- Approval of changes in CRSP organization in response to recommendations of External Evaluation Panel and AID Management Review.

Technical Advisory Committee

The Technical Advisory Committee advises the Board of Directors and the Program Manager on technical aspects of CRSP planning and performance. The original members of the Committee, each representing one of the three major institutional participants in the program, continued to serve through the reporting period. These individuals are:

Dr. Donald Garling
Department of Fisheries and Wildlife
Michigan State University

Dr. R.O. Smitherman
Department of Fisheries & Allied Aquacultures
Auburn University

Dr. George Tchobanoglous
Aquaculture Program
University of California at Davis

During the reporting period, the Technical Advisory Committee had the lead role in the development of the research plan for the third year of CRSP activities. At the annual meeting in Honolulu, Hawaii, March 18-21, 1985, the Technical Advisory Committee guided the research planning process. With this guidance, the CRSP Research Team (composed of U.S. and Host Country Principal Investigators) made a number of changes in the standardized research plan. Committee members then incorporated the Research Team's comments in a draft version of the CRSP Work Plan: Third Experimental Cycle.

Program Management Office

The Program Management Office provides executive linkage between the Management Entity and operations under the CRSP. The personnel of the Management Office has changed somewhat since the second reporting period. The staff now includes:

Dr. James E. Lannan, Program Director (0.5 FTE)
Ms. Michele Leslie, Asst. Program Director (1983-1985)
Ms. Nancy Brown, Asst. Program Director (Administration and Communications) (1.0 FTE) (1985-present)
Dr. Kevin Hopkins, Asst. Program Director (Data Management and Technical Affairs) (0.5 FTE) (1985-present)
Ms. Carman McBride, Secretary (0.5 FTE)
Fiscal Officer
Mr. William R. Millison
Office of Business Affairs
Oregon State University

During the reporting period, the Program Management Office continued to facilitate and coordinate interactions between collaborating institutions, monitor research activities, and prepare summary and fiscal reports. Specific accomplishments include:

- Preparation of CRSP budgets and subcontract modifications extending funding and performance period
- Continued assistance in processing travel clearances for CRSP personnel and approvals for purchases of "restricted goods" for country projects
- Implementation of a technical information service for overseas research staff
- Coordination of Triennial Review activities
- Implementation of a U.S. Research Component

- Conclusion of a new operating agreement between Institut Pertanian Bogor, Michigan State University, and USAID/ Jakarta to redirect the CRSP Special Topics Research towards identified Indonesian priorities.

- Conducting a third annual CRSP research meeting, and producing a work plan for the third experimental cycle.

- The development and utilization of an improved Data Base Management System which greatly expands CRSP capabilities for data analysis, synthesis, and modelling.

- Sending out an RFP for the hiring of a Data Synthesis Team which will coordinate the data base management system

In support of this list of accomplishments, additional detail is provided below for two categories: CRSP Reports and Documents and the CRSP Data Management System.

CRSP Reports and Documents

A number of reports and documents were prepared and disseminated during the third operational year of the CRSP. These are briefly described below.

Second Annual Administrative Report. Pond Dynamics/Aquaculture CRSP, Program Management Office, December 1984. Second Annual Administrative Report. Oregon State University, Marine Science Center, Newport, Oregon.

This 35 page report addresses the management and technical accomplishments of the CRSP during the reporting period from 1 September 1983 through 31 August 1984. Included are a statement of program objectives, a description of initial research efforts by projects in six host countries, a staff summary, and a financial statement for the reporting period.

CRSP Work Plan. Pond Dynamics/Aquaculture CRSP, Program Management Office, July 1985. CRSP Work Plan: Third Experimental Cycle. Oregon State University, Marine Science Center, Newport, Oregon.

This document is a further refinement of the second CRSP work plan. The third cycle experiments are intended to expand the quantitative baselines initiated during the first two years of research. Based on experiences to date, the plan was developed to compare the responses of ponds to varying levels of organic fertilizer.

External Evaluation Report. Pond Dynamics/Aquaculture CRSP, Program Management Office, March 1985. Evaluation Report. Oregon State University, Marine Science Center, Newport, Oregon.

The results of an external evaluation of the CRSP by a panel composed of three impartial senior scientists. The evaluation was the result of project site visits and meetings with project participants at the CRSP annual meeting.

Updated CRSP Directory. Pond Dynamics/Aquaculture CRSP, Program Management Office, August 1985. CRSP Directory. Oregon State University, Marine Science Center, Newport, Oregon.

This is the third update of the CRSP Directory which brings staff information up to date and includes short resumes of program participants.

CRSP Newsletter. Pond Dynamics/Aquaculture CRSP, Program Management Office, 1983-1985. AQUANEWS: The Newsletter of the Pond Dynamics/Aquaculture Collaborative Research Support Program.

During the reporting period, four issues of the quarterly CRSP newsletter were published. Each issue included a brief informative article on a particular CRSP project, a message from the Program Director, and brief articles and notes on various aspects of the program. The newsletters are distributed not only to CRSP participants and AID and BIFAD representatives, but to some 200 other interested persons.

CRSP Data Management System

A plan for CRSP data reporting was implemented in 1983. The plan was based upon a data base system in use at Auburn University. This system employed a commercially available data base management program called "The General Manager" and APPLE IIe personal computers.

An explosion of personal computer technology has taken place since implementation of the CRSP, and more powerful and versatile software and hardware is now available. It became apparent by 1985 that continued use of "The General Manager" would limit opportunities to use these new tools for CRSP data analysis. Consequently, the decision was made to discontinue use of "The General Manager" before the CRSP Data Base became too large to change, and to shift to a more versatile and powerful system. The CRSP has now implemented a new data management system.

The new system provides for simplified data entry in the field using any one of three commercially available software packages. It provides numerous hardware options; the CRSP researchers are no longer limited to Apple computers. Field data files are forwarded on diskettes to the Program Management Office, where they are transmitted electronically into the centralized data base maintained on a mainframe computer at Oregon State University. Specific data sets may be retrieved from the mainframe files in virtually any format. Thus data analyses can be accomplished with nearly any existing or future hardware or software.

The present status of the system is:

- Development and testing of data entry procedures is completed. Data reporting instructions and templates are being prepared for distribution to the projects.

- The Program Management Office is in the process of entering all field data reported to date into the central data base. It is anticipated that data entry will be completed by February 1986.

- A Research Funding Proposal for a Data Synthesis Team has been sent out. The Team should be in operation by November 1985.

External Evaluation Panel

The External Evaluation Panel (EEP), referred to as the "Program Review Panel" in the CRSP grant document, is composed of impartial senior scientists selected on a world-wide basis by the Board of Directors and approved by the Joint Committee of Agricultural Research and Development (JCARD) of the BIFAD. The panel is responsible for carrying out periodic external reviews of program accomplishments, progress and prospects. During the reporting period, the following individuals served on the Panel:

Dr. James Avault, Jr.
Professor of Fisheries
School of Forestry and Wildlife Management
Louisiana State University

Dr. Kenneth Chew
Chairman, Division of Aquaculture & Invertebrate Fisheries
School of Fisheries
University of Washington

Dr. Richard A. Neal, Director General
International Center for Living Aquatic Resources Management
Metro Manila, Philippines

Dr. Ziad Shehadeh
Manager, Aquaculture Program
Mariculture and Fisheries Department
Kuwait Institute for Scientific Research

Dr. Neal left the EEP in March, 1985 when he accepted a position with USAID. The CRSP Board of Directors is presently considering nominations for his replacement.

Since its appointment in 1984, the EEP has conducted a comprehensive program evaluation as part of the CRSP Triennial Review. This was accomplished by project site visits, and interviews

with project particiants at the Third Annual Meeting in March. A report was subsequently published in March 1985.

RESEARCH ACTIVITIES

Six collaborative research projects have been fully implemented during the present reporting period:

- Honduras/Auburn University
- Indonesia/Michigan State University
- Panama/Auburn University
- Philippines/University of Hawaii
- Rwanda/Oregon State University
- Thailand/University of Michigan

Because each collaborative project encountered different problems during implementation, the standardized experiments at each location have progressed at different rates. The stage of completion of the standardized work plans for each project are summarized in Table 1. The absence of synchrony among the various projects does not compromise the program technically but confounds publishing program results since the standardized data cannot be fully assembled until all sites have completed a particular experiment. Those projects which encountered the greatest delays are presently accomplishing the first and third cycle of experiments concurrently so that the several projects should be more closely synchronized in the future.

The following project summaries have been submitted to the Program Management Office by the Principal Investigators.

HONDURAS - AUBURN UNIVERSITY PROJECT

U.S. LEAD INSTITUTION	PRINCIPAL INVESTIGATOR
Auburn University	Dr. Ron Phelps
HOST COUNTRY LEAD INSTITUTION	**PRINCIPAL INVESTIGATOR**
Directorate of Renewable Natural Resources (RENARE) Ministry of Natural Resources	Ing. Jonathan Espinoza

POND CULTURE SYSTEMS INVESTIGATED

Cooler water tropical ponds at medium to high elevations in Latin America.

Auburn University was established as the U.S. lead institution for the Honduras Project by an agreement with the Management Entity, signed in November 1982. A Memorandum of Agreement between Auburn

TABLE 1
STATUS OF THE GLOBAL EXPERIMENT

PROJECT	FIRST EXPERIMENTAL CYCLE		SECOND EXPERIMENTAL CYCLE		THIRD EXPERIMENTAL CYCLE	
	dry season	wet season	dry season	wet season	dry season	wet season
Honduras	completed	completed	completed	in progress		
Indonesia	completed	completed	completed	in progress		
Panama:						
Brackish water	completed	completed	completed	completed	in progress	
Fresh water	completed	in progress				
Phillipines	completed	completed	completed	completed	in progress	
Rwanda	(To begin November 1985)					
Thailand	completed	completed	completed	in progress		

University and the General Directorate of Renewable Natural Resources of the Republic of Honduras, signed in December 1982, authorized the initiation of pond dynamics studies within the host country. In association with the formalization of the host country agreement, a research site review was undertaken, twelve ponds located at the Comayagua Aquaculture Station were reserved for CRSP activities, and basic needs for equipment and supplies were identified.

RESEARCH ACTIVITIES

The Cycle I CRSP studies at the El Carao Research Station were completed December 10, 1984. The mean net fish production for both the dry and rainy season phases were similar, 412 and 398 kg/ha respectively. Growth of fish during each season was similar during the first one hundred days of each cycle. Sexing errors of smaller fish used during the rainy season phase led to an average of 93 kg/ha of reproduction. No difference in survival of initial stock was noted among the seasons.

The Cycle II dry season study began January 16, 1985 following the second year work plans. An additional treatment was added and sampled following the protocol for the principal CRSP study. The treatments were inorganic fertilizer, chicken litter and cow manure. Fertilizer rates were adjusted to add the inorganic or organic fertilizers at a rate equivalent to nitrogen and phosphorus levels found in the 500 kg/ha/week of chicken litter (dry weight) added in the chicken manure treatment.

In an effort to better understand the nature of turbidity development in the ponds, total solids and total volatile solids were determined just prior to the first application of fertilizer, days 1, 2, and 3 after, and weekly thereafter.

The Cycle II dry season study was completed June 15. Fish production was considerably greater in the second cycle relative to the first. Yields averaged 1978 kg/ha, 1603 kg/ha and 1390 kg/ha for the chicken manure, cow manure and inorganic treatments respectively. All ponds developed obvious plankton blooms. Clay turbidity was reduced considerably in all treatments but still significantly greater in the cow manure treatment than the other treatments. Total solids were greater in the two organic treatments than the inorganic. Early morning dissolved oxygen levels were greater in the inorganic treatment ($X = 5.74$ mg/l) and less in the chicken (3.4 mg/l) and cow (2.37 mg/l). Total hardness and alkalinities were greater in the organic manure treatments. Greater ammonia levels occurred in the inorganic treatment.

The Cycle II rainy season study began July 26, 1985 and will end the third week of December 1985. It was not possible to have the additional treatment using cow manure due to difficulties in transporting the amount required.

OTHER RESEARCH ACTIVITIES

The effect of clay turbidity has been a concern at the El Carao Station. In the Cycle I studies, Secchi disc visibilities of less than 15 cm were common with little apparent plankton blooms and low fish production. This issue was addressed as part of the Cycle II CRSP study discussed earlier. The higher nutrient levels used in Cycle II resulted in plankton blooms in all treatments. The addition of cow manure did result in greater Secchi disc visibilities but also greater amounts of volatile solids than the other treatments. The addition of higher nutrient rates, particularly organics, resulted in more productive pond systems. The average size of fish produced in Cycle II were 204, 172, and 150 g for the chicken, cow and inorganic treatments respectively. The average sizes obtained in the inorganic Cycle I were 45 and 60 grams.

The principal CRSP studies have been designed to address the fundamentals of pond dynamics but at the same time several issues of more immediate concern to Honduras have been addressed. Assistance has been given to counterparts conducting experiments addressing local issues. One such issue is the production of fingerlings. Interest in aquaculture in Honduras continues to grow resulting in an increased demand for fingerlings from government stations such as the El Carao Station. Improving the fingerling production techniques at the El Carao Station is a necessity. A study is underway to determine the effect of broodstock density and water temperature on the production of hybrid tilapia fingerlings. This is to optimize fingerling production per pond and understand the influence of seasonal temperature changes on production. Densities of one fish per 4 m^2 and 2 m^2 are being tested for both the rainy and dry seasons. Further studies are anticipated to develop improved production of all-male tilapia fingerlings including the use of steroids for sex reversal.

Efforts have been made to reproduce the chinese carps through induced spawning. Successful spawns have been obtained using fresh carp pituitary. Incubation procedures most appropriate for the station have not been established resulting in low fry survival. Increased effort will be given to establishing the most appropriate incubation and pond management procedures for chinese carp production.

Another role of the El Carao Station is to develop practical production systems for Honduras. The use of organic manures in the Cycle II CRSP studies is a step in that direction. An additional study was conducted to determine the relative value of a corn gluten feed vs. a pelleted fish feed for a polyculture of tilapia, silver carp and grass carp. Data from this study is currently being processed.

OTHER ACTIVITIES

A major contribution of the Honduras CRSP has been to help rejuvenate an interest in aquaculture. Meetings with various government officials and field days at the El Carao station have drawn attention to the program and promoted an interest in aquaculture.

The CRSP program has provided opportunities for university students to receive practical experience in aquaculture, as well as conduct their thesis research. Three students conducted their thesis research at the station during the past year.

U.S. Research Associate Bart Green has participated in a variety of training programs and workshops, giving lectures on general fish culture, water quality and integrated aquaculture. Audiences have included Honduran government officials, extension agents, Peace Corps volunteers, agricultural students and forestry students.

INDONESIA - MICHIGAN STATE UNIVERSITY PROJECT

U.S. LEAD INSTITUTION	PRINCIPAL INVESTIGATORS
Michigan State University	Dr. C.D. McNabb/Dr. Ted Batterson
HOST COUNTRY LEAD INSTITUTION	**PRINCIPAL INVESTIGATORS**
Institute Pertanian Bogor (IPB)	Dr. M. Eidman/Dr. Kusman Sumawidjaja

POND WATER SYSTEMS INVESTIGATED

Cooler water tropical ponds at medium to higher elevations in Asia.

The CRSP/Indonesia aquaculture project is located in Bogor, West Java. This project is a collaborative effort between Michigan State University and Bogor Agricultural University (Institut Pertanian Bogor) (IPB). The research site is the Darmaga Fisheries Station of IPB located 14 km south of Bogor at an elevation of 220 m above sea level. Twelve fish culture ponds are utilized for CRSP activities. During this reporting period the research site was prepared, the second experiment (dry season) was completed and the second experiment (wet season) was initiated and nearly completed.

RESEARCH ACTIVITIES

Many tropical locations have distinct wet and dry seasons. However, the Indonesian CRSP site in Bogor, West Java has a wet-tropical climate year around. Except in El Nino years when the west Pacific tropical region becomes unusually dry, rainfall averages approximately 1.3 cm day^{-1} October through May, and 0.9 cm day $^{-1}$ June through September. On the average, August is the driest month

with 0.8 cm of rain per day. Evaporation rates on site are low and relatively constant year around. Because of these climatic conditions, true dry-season experiments have not been conducted at Bogor.

During this reporting period the project team completed the second experiment of the first experimental cycle of the standardized CRSP (begun in June 1984 and completed in November 1984) as well as the first experiment of the second experimental cycle (begun in January 1985 and completed in June 1985). The second experiment of the second experimental cycle was initiated in late August 1985 and will terminate in January 1986.

Results of the second experiment of the first experimental cycle were similar to the first experiment in which there was low yield of Oreochromis niloticus: 560 kg ha $^{-1}$ and 605 kg ha $^{-1}$ in experiments one and two respectively. Data showed that food production for fish (algae and aquatic invertebrates) was low. Data also suggested that the following were most likely to be limiting fish-food production: low alkalinity and carbon dioxide concentrations, low nitrogen, high suspended soil particulates which severely reduced light penetration, and surfactants from detergents. For the Host Country special topics during the second experimental cycle a Water Conditioning System (WCS) was constructed and put in use for conditioning source water for four of the 12 experimental ponds. The purpose of the WCS was to improve water quality for fish production by increasing alkalinity and concomitantly buffering pH changes in pond water so that carbon dioxide would not become limiting to fish-food production. In addition it was hoped that the WCS would improve water quality by removing soaps, detergents, and pesticides that were known to be used extensively within drainage systems from which fish-farms in Indonesia obtain water.

OTHER RESEARCH ACTIVITIES

Host Country Special Topic research focused on improving water quality through the use of the Water Conditioning System (WCS). This work was an integral component of the second experimental cycle. The WCS was constructed during the months of November and December 1984. It consists of a series of three contiguous cement-lined rectangular cells. The first cell has a surface area of 47 m^2, a volume of 62.8 m^3, and was filled with crushed limestone; the second cell has a surface area of 99 m^2, a volume of 140.0 m^3, and was filled with crushed limestone overlain with sand; and the third cell has the same dimensions of the first but was filled with charcoal. The source water for the WCS was drawn from the same irrigation canal that provided water for CRSP ponds. It first passed through a small basin in which large floating debris was screened and large suspended particles settled out. From there water entered the surface of the first cell of the WCS and discharged via a stand pipe to the next cell. From the second cell it passed to the third cell and from there discharged to a system of small concrete troughs that distributed the water to the fish culture ponds.

Four CRSP ponds were filled and maintained with water from the WCS and fertilized with organic animal wastes. Another set of four CRSP ponds were filled with unconditioned water and fertilized with organic wastes. The protocol stated that organic wastes were to be applied at a rate of 500 kg dry weight per hectare per week. For these experiments, locally available chicken manure was used as the organic nutrient source. The wastes were analyzed for nitrogen, phosphorus, potassium, and organic carbon. The average value for five sub-samples on a dry weight basis were: N = 1.65%; P = 2.44%; K = 1.60%; and Organic Carbon = 54.41%. A third set of four CRSP ponds constituted the last experimental treatment. They received untreated source water and were fertilized with triple-super-phosphate and urea at levels of Total N and Total P that gave the same TN and TP loading as organic fertilizers.

Results of this 150 day grow-out study (January through June 1985) showed that the ponds with conditioned water supported increased growth of planted adult fish and growth of fry. These ponds averaged 14% greater growth in adults and 135% increased fry production over the other two treatments. Overall, there was a 46% increase in fish harvest in the ponds receiving conditioned water. This treatment was effective in increasing alkalinity by 113%. The increased alkalinity was shown to stimulate primary production which, in turn, resulted in the increased fish yields: 1035 kg ha^{-1} with organic fertilizer and unconditioned water and 1455 kg ha^{-1} with organic fertilizer and conditioned water. The second experiment of the second experimental cycle is now underway.

OTHER ACTIVITIES

During the completion of the second experiment of the first experimental cycle, IPB fisheries students who had collected data for thesis work during the first experiment completed their requirements and tests for graduation. Students completed work in areas such as growth rate, mortality and feeding habits of Oreochromis used in the CRSP project, and the composition, abundance and diversity of zooplankton in the CRSP ponds. Since the program involving students with CRSP activities was so successful it was continued into the second experimental cycle.

PANAMA - AUBURN UNIVERSITY PROJECT

U.S. LEAD INSTITUTION	PRINCIPAL INVESTIGATOR
Auburn University	Dr. Ron Phelps
HOST COUNTRY LEAD INSTITUTION	**PRINCIPAL INVESTIGATOR**
National Directorate of Aquaculture, Ministry of Agriculture (MIDA)	Dr. Richard Pretto

POND CULTURE SYSTEMS INVESTIGATED

1) Small, low intensity tropical pond systems in Latin America characterized by limited external inputs of feed and fertilizers

2) Brackish-water and hypersaline ponds in Latin America.

3) Fry production systems in support of all types of pond productio systems.

Auburn University was established as the U.S. lead institution for the Panama Project by an agreement with the Management Entity, signed in November 1982. A Memorandum of Agreement between Auburn University and the Ministry of Agricultural Development of the Republic of Panama, signed in December 1982, authorized the initiation of pond dynamics studies within the host country.

Panama Brackish-water Research

The Cycle II CRSP experiments were completed in May 1984 and Cycle III studies begun in July. Cycle II studies were integrated into a larger research plan for the year with the principal CRSP studies being complimented with other related treatments. Penaeus vannamei juveniles (0.5-1.0 g) at $4/m^2$ were used in all treatments. The experimental treatments were as follows with all ponds receiving a pretreatment of manure:

CRSP baseline - inorganic fertilizer, 100 kg/ha 20-20-0, one application, 6 ponds.

CRSP baseline - inorganic fertilizer, 100 kg/ha 20-20-0, one application, 25% protein pelleted feed added daily.

Control - pretreatment of manure only.

Feed only - 25% protein pelleted feed added daily.

Silica - silica as rice hull ash (100 kg/ha ash) one application.

Silica and inorganic - 100 kg/ha ash hulls, 100 kg/ha 20-20-0, one application.

Silica, inorganic, and feed - 100 kg/ha ash hulls, 100 kg/ha 20-20-0 one application, 25% protein feed added daily.

All ponds were monitored following the CRSP work plan.

The shrimp production in the rainy season phase was 249 kg/ha in the inorganic only CRSP ponds and 548 kg/ha in the CRSP ponds receiving feed only. The average weight of shrimp in the unfed treatment was 9.5 g with 65.5% survival and in the unfed treatment 18.6 g and 74.5% survival.

In the dry season the production in unfed ponds averaged 155.8 kg/ha and 237 kg/ha in fed ponds. The average weights in the dry season were 7.1 and 7.6 g with survivals of 54.4 and 78.1% for the unfed and fed treatments respectively. Thus considerably better production of P. vannamei was obtained during the rainy season.

Water quality in the rainy season Cycle II experiments showed no significant differences in nitrate, nitrite, salinity, silica, total dissolved phosphorus or total reactive phosphorus among fed and unfed CRSP ponds. Ponds receiving feed did have a significantly higher ammonia level than unfed ones (52.29 vs. 37.01 mg/l).

Chlorophyll-a values were greater in the unfed treatment. There were no significant differences in chlorophyll-b or -c among the fed and unfed CRSP ponds.

Water quality data from the dry season of Cycle II is currently being processed. Data for the other treatments conducted along with Cycle II is also now being processed.

Cycle III wet season is now underway. It is designed to determine the effect of water exchange rates on shrimp production and nutrient concentrations in ponds. Water exchange is a common but poorly understood practice in brackish-water aquaculture. In shrimp culture the costs of daily water exchange can be greater than 20% of the production costs. The role of water exchange is not clear nor are the optimum rates well defined.

The Cycle III wet season treatments are all stocked with P. vannamei juveniles at $4/m^2$ and fed a 25% commercial sinking pelleted feed. The treatments are as follows:

a. no water exchange
b. 5% daily water exchange
c. 10% daily water exchange
d. 20% daily water exchange
e. 5% daily water exchange plus pre-stocking chicken manure application.

The wet season phase is scheduled to continue until December 1985. Low dissolved oxygen in the no water exchange treatment has necessitated water being added to prevent mortality. Recent difficulties have occurred in obtaining an adequate volume of water of good quality to fill the feeder reservoir of the station. This has resulted in difficulties in maintaining the daily water exchange rates.

OTHER RESEARCH ACTIVITIES

David Hughes has participated with the staff of the brackish-water station in the design and implementation of various experiments. During the past year additional studies have been

conducted regarding nutrition, species combinations and shrimp-fish polycultures.

The need to determine the most appropriate species or species combination is an important aspect for shrimp culture in Panama. Penaeus vannamei and P. stylirostris are the species commonly cultured but the advantages or disadvantages of each or a polyculture of both was not clear. Efforts were made to better understand this aspect. During the dry season of 1985 the following experiment was conducted. All ponds were managed as a Cycle II fed CRSP pond. The stocking density was 4 juveniles/m^2 but the species ratio varied:

a. 25% P. vannamei, 75% P. stylirostris
b. 50% P. vannamei, 50% P. stylirostris
c. 75% P. vannamei, 25% P. stylirostris
d. 100% P. stylirostris

The fed 100% P. vannamei of the Cycle II CRSP dynamics study served as another treatment for this study.

The greatest production was obtained in the 100% P. vannamei treatment of 222 kg/ha with the lowest being 138 kg/ha for the 25% P. vannamei, 75% P. stylirostris treatment. Survival was very low for P. stylirostris ranging from 15.6 to 29.7%. P. vannamei survival was greater ranging from 66.7 to 88.0%. In the dry season 1984 Cycle I study using postlarvae for stocking, the presence of P. vannamei appeared to reduce the survival of P. stylirostris. In this study the survival of P. stylirostris was lower and appeared to not be influenced by the presence of P. vannamei.

As discussed earlier the CRSP dynamics study was incorporated as treatments of a larger study regarding nutrient inputs in shrimp ponds. The value of silica in the form of rice hull ash was studied as a supplement to either normal fertilization or feeding practices for both the 1984 rainy and 1985 dry seasons. At the rate used in the study, rice hull ash did not improve shrimp yields in ponds receiving feed. Rice hull ash added along with inorganic fertilizer did result in a greater yield, average weight and survival over fertilizer only.

A shrimp-fish polyculture experiment was begun in the 1985 wet season to determine if the mullet Mugil curema could be cultured successfully together with P. vannamei without reducing shrimp yields. The experimental design was that P. vannamei juveniles were stocked at 4/m^2 and fed a commercial shrimp ration. Mullet were stocked at the following densities: 0, 1/10m^2, 2/10m^2, 4/10m^2, and 6/10m^2. This experiment is scheduled to end December 1985.

A shrimp nutrition study also was begun in the wet season 1985. The goal is to have a better understanding of appropriate protein levels for shrimp feeds when locally available ingredients are used. The levels of protein being tested are 25%, 32.5%, and 40%. The rations are prepared by station staff as a pelleted feed and given

daily to P. vannamei juveniles stocked at $4/m^2$. This study is scheduled to end in December 1985.

An effort to understand pumping efficiencies and water exchange rates was begun in the wet season 1985. The efficiency of the pump system supplying the station was determined for different tidal stages with water flow rates and fuel consumption documented. Attempts were made to determine flow rates through the commercial scale ponds but were unsuccessful due to difficulties in positioning of weirs.

OTHER ACTIVITIES

The CRSP program has provided various training opportunities for university students. One or more students have participated in the earlier mentioned research programs. Lectures have been given to a variety of groups regarding water quality management and the use of feeds and fertilizers. At the request of USAID/Honduras, David Hughes participated in a team to evaluate potential sites for the construction of shrimp farms on the Pacific coast of Honduras. A technical paper was given at the 1985 World Mariculture Society meeting regarding experimental work conducted at the brackish-water station.

Ed Kennel, a wind systems specialist with VITA, has provided technical assistance regarding the solar and wind potential at the brackish-water station for supplying energy to pump water. Two computerized anemometers were installed by VITA and the data collected will be analyzed by that agency to give further recommendations regarding the use of wind power.

Panama Freshwater Research

CRSP activities have continued at the Gualaca and Divisa stations. David Teichert-Coddington arrived in-country January 29 to assume responsibility as U.S. Research Associate for freshwater studies for the Panama CRSP. The Cycle I dry season phase was completed at Gualaca May 21, 1985. The rainy season phase is underway and will end in December 1985.

In the dry season phase, the growth of the initial stock had stopped after the first month and all ponds were harvested at the end of three months. Net production was 93 kg/ha ranging from 17 to 196 kg/ha. Mean survival was 86%.

There were no significant differences among ponds in the water quality parameters measured. There was no difference among ponds in chlorophyll-a levels but there were significant differences in Secchi disc visibility. In general the ponds were not very productive, total phosphorus levels averaged only 0.08 mg/l, there were little diurnal changes in dissolved oxygen and often the pond clarity was such that the pond bottom was visible.

OTHER RESEARCH ACTIVITIES

Gualaca

Pond seepage has been a problem at Gualaca with rates ranging from 2 to 12 cm/day. To better understand water loss from the CRSP ponds, a water budget study was initiated. Twelve ponds used in the CRSP study are monitored daily for water lost. Six ponds will be monitored closely with inlet pipes having water meters installed. The watershed for these six ponds is measured and the rainfall and runoff monitored. Pan evaporation is determined. Seepage is estimated by subtracting the calculated pond evaporation from total water loss minus any corrections for water gains. Correlations between water loss and fish production, and water and soil quality variables will be determined at the end of each CRSP study.

The soils of the ponds at Gualaca are highly acidic with base saturations of 8-13%. These acidic soils influence the availability of minerals in the water column. A study is underway to investigate the interaction between soil and water chemistry as regards phosphorus and iron. The study will explore the influence of soil pH and limestone on the concentrations of total and ortho-phosphorus, and iron in soil and water.

Preparations have been made to study the red color phase of tilapia. This color phase has received considerable attention as an aquaculture substitute for red snapper. Separate non-CRSP funding has been obtained to conduct this study. It will emphasize the production of all male populations through sex reversal or hybridization. In addition, a marketing study will be conducted to determine the acceptability of red tilapia in Panama.

Divisa

Improvements in fingerling production techniques has been a concern of DINAAC (the government aquaculture program). A growing demand for fingerlings has pressed the available facilities to meet the demand. Techniques developed through the CRSP program have been adopted as routine hatchery procedures and are helping to meet the fingerling demand. Further experimentation is continuing at Divisa to improve fingerling production techniques.

In a study to determine if an 8 or 15 day harvest cycle of tilapia hapas was best, it was found a greater number of free swimming fry could be obtained from a 15 day harvest cycle. Similar numbers of seed (eggs to swimming fry) per m^2/day were obtained from both schedules.

PHILIPPINES - UNIVERSITY OF HAWAII PROJECT

U.S. LEAD INSTITUTION	PRINCIPAL INVESTIGATORS
University of Hawaii	Dr. Philip Helfrich Dr. Arlo Fast
HOST COUNTRY LEAD INSTITUTION	**PRINCIPAL INVESTIGATOR**
University of the Philippines in the Visayas	Dr. Jose A. Carreon

POND CULTURE SYSTEMS INVESTIGATED

Brackish-water and hypersaline tropical ponds in Asia

The research activities of the Collaborative Research Support Program (CRSP) on Pond Dynamics are performed at the Brackishwater Aquaculture Center (BAC), College of Fisheries (CF) of the University of the Philippines in the Visayas (UPV) at Leganes, Iloilo, Philippines. The University of Hawaii (UH) is the collaborating United States counterpart institution to UPV.

The BAC is located approximately 17 km north of Iloilo City, the capital of Iloilo Province on the Island of Panay. The facilities of BAC include eight buildings with three chemical laboratories, one wet laboratory, one feed processing laboratory, one hatchery laboratory, and 217 units of earthen brackish-water ponds. Of these, 18 units of 1,000 sq m ponds are devoted to CRSP baseline research on marine shrimp, while another 21 units of 500 sq m ponds are devoted to CRSP baseline research on Tilapia nilotica. Additional pond and laboratory space are made available to CRSP by the BAC for both baseline and special topic research. The laboratories are equipped with instruments and other equipment.

The CRSP team at BAC for the first cycle was made up of the UH and UPV Research Associates, faculty members of the UPV-CF, research staff of BAC, research aides, administrative people, full-time and part-time laborers, and one driver. Other BAC employees were available on request. These personnel are well-trained in various aspects of aquaculture, such as hatchery management, pond production and management, fish feed development and nutrition of the species being used, soil and water management and other specialties. The UH Research Associate, Jim Woessner, returned to the U.S. during June to begin his studies at the University of Miami's medical school. Dr. Woessner was replaced by Dr. Kent Carpenter during July. Dr. Carpenter has previously served in the U.S. Peace Corps in the Philippines. Their UPV counterpart Research Associate is Dr. Romy D. Fortes, Director of the BAC.

RESEARCH ACTIVITIES

The first cycle research experiments were concluded during July 1984. These included the standardized CRSP baseline design with T. nilotica and the milkfish Chanos chanos. During each half (wet/dry season) of the cycle, milkfish (3000/ha) and Nile tilapia (5000/ha) were stocked in six phytoplankton (deep - 60 cm) and twelve lablab (shallow - 30 cm) 1000 sq m ponds. Each species was kept in monoculture in half, i.e., three and six ponds of each culture type. Data was collected as prescribed in the CRSP protocol documents, and data has been submitted to the Program Management Office. The first half of the 1st Cycle results have been analyzed and submitted in report form, while the second half of the first cycle is still being analyzed.

Following completion of the first cycle work in July 1984, 18 units of the CRSP baseline 1,000 sq m ponds were modified in preparation for the 2nd cycle shrimp baseline research. These modifications included: deepening of 6 ponds to accommodate water depths of 1.0 m; and renovation of 6 ponds to accommodate water depths of 0.5 or 1.0 m. In addition: electricity was run to each pond; water circualtion devices were installed on 9 of the 18 ponds; and a high volume water pump was installed on the source water canal such that water could be pumped into the secondary supply canal even between the twice monthly tidal peaks. These modifications allowed us to conduct a factorially designed experiment with 3 depth treatments and two levels of water circulation. The first half of the second cycle shrimp mainline experiments occurred from November 1983 through April 1984; the second half of the second cycle shrimp mainline experiments occurred from July 1984 through December 1984. These represent the dry and wet seasons respectively. Data were collected in accordance with CRSP protocol, and are now being analyzed for presentation in report form.

Our second mainline experiments were with Tilapia nilotica. These experiments were conducted in 500 sq m ponds which were renovated for this study. Treatments included: controls, manure applications, and feed applications. There were three replicates for each treatment. These second cycle tilapia experiments were conducted during roughly the same time frames according to CRSP protocol. These data are now being analyzed for completion reports.

One major problem at the BAC has always been the intrusion of unwanted species into experiments. With shrimp, tilapia are the most common intruder, and have sometimes approached or exceeded the biomass of the "experimental" shrimp. This was a problem during the first half of the second cycle experiments. During the second half of the second cycle we conducted experiments with teaseed cake applications. These proved very successful in eliminating fish without any deleterious effect on the shrimp. Two teaseed cake treatments during the five month grcwout period effectively eliminated fish intruders from our ponds.

OTHER RESEARCH ACTIVITIES

During 1984, we conducted several special research studies in support of the mainline project. These studies included:

a) Selective Elimination of Finfishes in Prawn Ponds (teaseed cake)

b) Preliminary Studies on the Feeding Habit of Milkfish (Chanos chanos) and Tiger Prawn (Penaeus monodon)

c) Water Quality Dynamics in Brackishwater Shrimp Ponds With Artificial Aeration and Circulation

During late 1984, UPV and UH CRSP collaborators were awarded a USAID funded PSTC grant to study culture techniques for the spotted scat (Scatophagus argus): "Innovative Fish Culture Techniques for the Spotted Scat." The scat is an important food fish in the Philippines, but is not commonly cultured. It has several desirable features for culture, including feeding habits close to the base of the food web, and wide salinity tolerance. Little is known about its spawning induction, and growout characteristics in ponds.

RWANDA - OREGON STATE UNIVERSITY PROJECT

U.S. LEAD INSTITUTION

Oregon State University

PRINCIPAL INVESTIGATORS

Dr. Richard Tubb/Wayne Seim

HOST COUNTRY LEAD INSTITUTION

National University of Rwanda

PRINCIPAL INVESTIGATOR

Dr. Valens Ndoreyaho

POND CULTURE SYSTEMS INVESTIGATED

Cooler water ponds at medium to higher elevations in Africa.

RESEARCH ACTIVITIES

A final memorandum of agreement was signed on November 12, 1983 and the Rwandan government released ponds for CRSP use on March 1, 1984. The Rwandan CRSP project has taken an unexpected two years to develop the personnel, cooperation and facilities to implement the CRSP work plan. The CRSP was delayed by lengthy negotiations regarding the use of Rwandan research facilities. A $170,000 grant from the European Common Market was provided for necessary pond renovation and to construct the 21 ponds used for CRSP research. In addition, a small laboratory building has also been constructed adjacent to the ponds.

On the advice of the CRSP review team, the start of pond research was delayed in order to start experiments with a pure strain of Tilapia nilotica. Broodstock numbers were increased and sufficient numbers of T. nilotica will be available on 1 November 1985. Cold weather during July and August delayed the growth of the fish. Twelve of the experimental ponds will be used for the first cycle of experiments and 9 ponds will be used to start the third cycle of experiments. On the advice of the technical committee, the second cycle of experiments was deleted in order to meet the CRSP schedule.

Substantial progress has been made in solving the problems of logistic support, technical training of students and support staff, broodstock development and coordination with other AID projects. By 30 August 1986 the project should be approaching parity with the other projects. At the Universite Nationale du Rwanda (UNR) the project has been given the highest priority. Mr. Felicien Rwangano has been named by UNR as the host country research associate, and Dr. Boyd Hanson continues as the U.S. research associate. Wayne Seim has been added as Co-PI from the OSU campus and he will travel to Rwanda with Richard Tubb in December 1985.

The algae, plankton, and benthos have been monitored by students as the new experimental ponds were filled. The aim has been to use background studies on the ponds to make students aware of the aquatic resources and to develop a facility for working with taxonomic keys to aquatic plants and animals.

OTHER RESEARCH ACTIVITIES

The on-campus research project at OSU was aimed at defining the role of UDP-GT in breaking down testosterone and estradiol concentrations in the liver. Since the injection of sex steroids is used to induce spawning, it is important to define the natural conditions which decrease UDP-GT concentrations even in tropical environments.

In vivo glucuronidation of phenolphthalein was inhibited in rainbow trout during onset of gonadal maturation (Comp. Biochem. Physio. 76C:107). We further examined this phenomenon in male and female carp by examining hepatic microsomal UDP-GT activity, plasma testosterone and estradiol concentrations, and histological changes in gonadal tissues in time-course studies. Onset of gonadal maturation was modulated by holding fish under different photoperiod/temperature regimens and administration of exogenous gonadotropins. In male and female fish with respective plasma testosterone or estrogen concentrations below 1 ng/ml, UDP-GT activity ranged between 10 and 15 nmol p-nitrophenol conjugated/gm liver/min. Elevations of sex steroids associated with maturational changes in gonads were coincident with 3-fold and greater reductions in UDP-GT activity. Enzyme activity recovered as plasma steroid concentration declined. Since UDP-GT metabolizes sex steroids its

inhibition was likely related to maintenance of hormonal concentrations required for gonadal development.

Several projects utilizing Tilapia rendelli were proposed for 1985 but the projects were canceled because of persistent disease problems with the species.

The cooperation with the Rwandan AID project directed by Auburn University has been most important. Dr. Karen Veverica has utilized the newly constructed ponds for training sessions, and the project has loaned the CRSP hard to find equipment and cooperated in many other ways. Drs. D. Moss and E. W. Shell of Auburn have been most helpful in supplying broodstocks and sharing information on their return from Rwanda. Dr. Ndoreyaho has been particularly interested in soil analysis, and he is using his atomic absorption unit to look at trace elements in the soil.

OTHER ACTIVITIES

Drs. Ndoreyaho and Hanson are investigating the possibility of offering short courses in aquaculture and the integration of aquaculture into farming practices. This is in the embryonic stage, but the idea along with the specialized pond research has attracted the attention of granting agencies from the European Common Market.

THAILAND - UNIVERSITY OF MICHIGAN PROJECT

U.S. LEAD INSTITUTION	PRINCIPAL INVESTIGATOR
University of Michigan	Dr. James Diana
HOST COUNTRY LEAD INSTITUTION	**PRINCIPAL INVESTIGATOR**
Department of Fisheries (DOF) Ministry of Agriculture and Cooperatives	Dr. Thiraphan Bhukaswan

POND CULTURE SYSTEMS INVESTIGATED

1) Small, low intensity tropical ponds in Southeast Asia characterized by limited external inputs of feed and fertilizer.

2) Higher intensity tropical ponds in Asia characterized by substantial inputs of feed and fertilizer.

RESEARCH ACTIVITIES

Dr. James Diana continues to serve as Project Principal Investigator. With sadness it is reported that Dr. Karl Lagler, Co-Principal Investigator, passed away in August 1985. Dr. Lagler's

participation on this and other projects world-wide will be sorely missed.

Thailand participants remain Dr. Kwei Lin (U.S. Research Associate), Dr. Thiraphan Bhukaswan (Thailand PI), Mr. Sompong Hiranyawat, and Mr. Somport Inkatawewat (Thailand research associates). Since moving the the primary study site from the Nong Sua Fish Hatchery to the Ayutthaya Freshwater Fisheries Center in July 1984, experiments have progressed well. The first experimental cycle was completed with the collection of wet season data between 1 August and 31 December 1984. Second cycle dry season experiments were conducted from 1 February to 30 June 1985, and second cycle wet-season experiments are currently underway having commenced in August 1985.

Wet Season Experiments, First Cycle

Protocols described in the first cycle work plan were followed to collect baseline data from 12 ponds (@ 400 m^2). Data were put on floppy discs using the General Manager program. Initial analyses indicated that fish growth was minimal under conditions of no fertilization and no supplementary feeding even though fish stocking densities were low. However, it was observed that fish grew to a greater extent than might have been expected given the measurements of chlorophyll-a and primary productivity. Dr. Lin observed that methods for measuring chlorophyll-a and primary productivity result in the measurement only of healthy and photosynthetically active algal biomass. However, total chlorophyll measurements indicate a high percentage of nonfunctional phaeophytin which may be as important to pond energetics as active chlorophyll. Alternatively, trophic-dynamics of these ponds may be largely based on bacterial food chains, which we are not measuring. Detailed, integrated analyses are on hold pending selection of a new data management program.

Dry Season Experiments, Second Cycle

Of 16 400 m^2 ponds assigned for use by the CRSP project, four were used for producing fingerlings (which took 2 months to reach sexable size), eight were used for the fertilization experiments detailed in the second cycle work plan, and four were used for site-specific projects.

The mainline pond dynamics experiments utilized organic and inorganic fertilizers of the following specifications:

1) Organic (chicken manure)
   Source: Poultry Dept. of Kasetsart University
   Chemical Analysis: organic matter (32.15%)
   pH (7)
   moisture (44%)
   total nitrogen (2.8%)
   total phosphorus (9.14% as P205)
   potassium (3.13% as K_2O)

Application Rate: 500 kg/ha/wk=46 kg P/ha/wk
=14 kg N/ha/wk
Application Method: Broadcast along pond edge

2) Inorganic (triple super phosphate (0-46-0) and urea (47-0-0))
Source: Commercial retailers in Bangkok
Application Rate: equivalent to 500 kg/ha/wk of manure
TSP=100 kg/ha/wk=46 kg P/ha/wk
Urea=30 kg/ha/wk=14 kg N/ha/wk
Application Method: suspend mixed fertilizer in the center of each pond.

Preliminary examination of second cycle dry-season data indicated that over the first three months of the experiment, fish growth (length and weight) in ponds treated with inorganic fertilizer was greater than in ponds treated with organic fertilizer. However, size of fish at the termination of the experiment was virtually identical for fish subjected to the two different treatments. Dr. Lin believes that the limiting factor controlling algal growth in the ponds appears to be nitrogen rather than phosphorus.

OTHER RESEARCH ACTIVITIES

Three pilot studies were initiated at the experimental station during the present cycle. In addition to these pilot studies, detailed reports of two former site-specific studies are included in Appendix I and listed under "Other Activities". The three studies included:

1) A project to produce all-male tilapia fingerlings through sex reversal using testosterone. This experiment was conducted as a joint effort with the Ayutthaya station. The CRSP provided the materials for sex reversal and services for water quality analysis, and the station provided personnel support. The experiment ran from March through August 1985 and results are currently being analyzed.

2) An experiment to investigate seasonality of spawning activity in Tilapia. This study was initiated in August 1985 and is being conducted in a series of 50 m^2 concrete ponds in which sexually mature Tilapia nilotica were stocked at a density of 3 fish/m^2 and with a sex ratio of 1M:2F. Fry are to be collected, removed, and counted monthly for a period of 1 year while water quality parameters (i.e., temperature, dissolved oxygen, ammonia, alkalinity, hardness, and turbidity) will be recorded weekly.

3) An experiment on all-female culture of Tilapia nilotica in ponds. Two ponds were used to stock sexually mature female fish under conditions identical to those of the mainline experiments. This experiment was started 1 February 1985 but was terminated one month later because seepage rate in the ponds was about 5 cm/day. Consequently, the ponds were drained for repair and a new experiment begun in August 1985.

In-country Research

Experiments addressing sex-related differences in energy accumulation have been initiated by U.S.-based personnel. These experiments involve evaluation of metabolic rates, food consumption, and assimilation efficiencies for male and female Tilapia nilotica of different sizes. Fish are being subjected to different temperatures and different rations. The tilapia being used for these experiments have been graciously provided in the spirit of collaboration by Michigan State University and Auburn University.

OTHER ACTIVITIES

A total of 25% of Dr. Lin's time has been devoted to the following activities:

1) Coordinating research projects on aquaculture at the Department of Fisheries, Kasetsart University. Research topics involve the culture of sand goby, catfishes, and snakehead.

2) Participation in extension service for freshwater prawn farmers. This is a joint effort with resources and personnel from the Thai Dept. of Fisheries and Network of Aquaculture Centers in Asia. Field experiments on pond dynamics and management in prawn grow-out ponds are being conducted.

Dr. Lin is preparing two manuscripts for submission to Aquaculture on the following subjects: a) Breeding and rearing of sand goby fry (with Panu Tavarutmaneegul); b) Acidification, fertilization, and management of fish ponds in acid-sulfate soils (with Panu Tavarutmaneegul). He is also presenting a paper entitled: "Culture of Freshwater Rotifers and Chironomid Larvae and Food for Fish Fry" at the Asian Symposium on Freshwater Fish Culture in October 1985 in Beijing, China. Dr. Lin has also presented a seminar on the scope and progress of the CRSP project to the USAID staff in Bangkok.

3. STAFF SUMMARY

The Pond Dynamics/Aquaculture CRSP represents the joint efforts of more than 40 professionals and a number of support personnel. As shown in Table 2, four major fields of specialization were represented during the reporting period: Research Administration, Limnology/Water Chemistry, Fisheries/Aquaculture, and Data Management.

There have been some changes in staff composition during this reporting year. Key additions to the group of CRSP participants include: David Teichert-Coddington, who jointed the CRSP as the U.S. Research Associate for the Auburn University/Panama freshwater project in Gualaca; Dr. Kent E. Carpenter, who replaced Dr. Jim Woessner as U.S. Research Associate for the University of Hawaii/Philippines project; Felicien Rwangano was hired as Host Country Research Associate for the Oregon State University/Rwanda project; and Mr. Sompong Hiranyawat and Mr. Somport Inkatawewat have joined as Host Country Research Associates for the University of Michigan/Thailand project.

In addition to staff with formal CRSP assignments, numerous individuals continue to participate in the development of host country projects. Almost all projects provide research facilities for graduate students to carry out thesis work. This not only aids host country institutions in placing graduate students in aquaculture research facilities, but also benefits the CRSP by adding related research results to data acquired from the standard CRSP plan. Professors, instructors, and research assistants at the University of the Philippines in the Visayas continue to play a major role in the accomplishment of the research program at the Iloilo site, as do the technical staff at the Ayutthaya Hatchery for the Thailand project. Auburn University staff at an AID project in Rwanda have been of great help in the development of the CRSP project there.

Table 2. PROFESSIONAL STAFF SUMMARY

Individual	CRSP Function	FIELD(S) OF SPECIALIZATION				Location of Work[1]
		Research Admin.	Limnology/ Water Quality	Fisheries Aquaculture	Data Management	
BOARD OF DIRECTORS						
Dr. Alfred M. Beeton	Chairman	●	●			Ann Arbor, MI
Dr. Wallis H. Clark, Jr.	Member	●		●		Davis, CA
Dr. Donovan D. MOss	Member	●		●		Auburn, AL
TECHNICAL ADVISORY COMMITTEE						
Dr. Donald Garling	Member			●		East Lansing, MI
Dr. R. Oneal Smitherman	Member			●		Auburn, AL
Dr. G. Tchobanoglous	Member			●		Davis, CA
MANAGEMENT ENTITY						
Dr. James E. Lannan	Program Director	●		●	●	Newport, OR
Ms. Nancy Brown	Assistant Program Director	●				Newport, OR
Dr. Kevin Hopkins	Asst. Program Dir			●	●	Corvallis, OR
Mr. William R. Millison	Fiscal Officer	●				Corvallis, OR

[1]Denotes primary work location and excludes host country site visits and travel for attendance of meetings.

Table 2. PROFESSIONAL STAFF SUMMARY (Continued).

Individual	CRSP Function	FIELD(S) OF SPECIALIZATION				Location of Work[1]
		Research Admin.	Limnology/ Water Quality	Fisheries Aquaculture	Data Management	
HONDURAS - AUBURN UNIVERSITY PROJECT						
Dr. Ronald P. Phelps[2]	U.S. Principal Investigator			•		Auburn, AL
Lic. Jonathan Espinoza O.	H.C. Principal Investigator			•		Comayaguela, D.C., Honduras
Mr. Bartholomew W. Green	U.S. Research Associate		•	•		Comayagua, Honduras
Ing. Pes. Hermes Alvarenga	H.C. Research Associate		•	•		Comayagua, Honduras
Mr. James Buston[2]	Technical Advisor				•	Auburn, AL
Mr. James L. McDonough	Administrative Advisor	•				Auburn, AL
INDONESIA - MICHIGAN STATE UNIVERSITY PROJECT						
Dr. Ted Batterson	U.S. Principal Invest.		•	•		East Lansing, MI
Dr. Clarence D. McNabb	U.S. Principal Investigator		•	•		East Lansing, MI
Dr. Muhammad Eidman	H.C. Co-Principal Investigator			•		Bogor, Indonesia
Dr. Kusman Sumawidjaja	H.C. Co-Principal Investigator			•		Bogor, Indonesia
Mr. Komar Sumantadinata	H.C. Research Associate			•		Bogor, Indonesia
Mr. Gerald Jacobs	Administrative Advisor	•				East Lansing, MI

[1]Denotes primary work location and excludes host country site visits and travel for attendance of meetings.
[2]Researchers involved in two projects.

Table 2. PROFESSIONAL STAFF SUMMARY (Continued).

Individual	CRSP Function	FIELD(S) OF SPECIALIZATION				Location of Work[1]
		Research Admin.	Limnology/ Water Quality	Fisheries Aquaculture	Data Management	
PANAMA - AUBURN UNIVERSITY PROJECT						
Dr. Ronald P. Phelps[2]	U.S. Principal Investigator			•		Auburn, AL
Dr. Richard Pretto M.	H.C. Principal Investigator			•		Santiago de Veraguas, Panama
Dr. David Hughes	U.S. Research Associate		•	•		Aguadulce and Divisa, Panama
Mr. David Teichert-Coddington	U.S. Research Associate		•	•		Gualaca, Panama
Mr. Orlando Garcia	H.C. Research Associate			•		Divisa, Panama
Lic. Nely Serrano	H.C. Research Associate			•		Gualaca, Panama
Mr. Azael Torres	H.D. Research Associate			•		Aguadulce, Panama
Mr. James Buston[2]	Technical Advisor				•	Auburn, AL
Mr. James L. McDonough	Administrative Advisor	•				Auburn, AL
PHILIPPINES - UNIVERSITY OF HAWAII PROJECT						
Dr. Philip Helfrich	U.S. Co-Principal Investigator			•		Kaneohe, HI
Dr. Arlo W. Fast	U.S. Co-Principal Investigator		•	•		Kaneohe, HI
Dr. Jose A. Carreon	H.C. Principal Investigator			•		Diliman, Quezon City, The Philippines
Dr. Kent Carpenter	U.S. Research Associate		•	•		Diliman, Quezon City, The Philippines

[1]Denotes primary work location and excludes host country site visits and travel for attendance of meetings.
[2]Researchers involved in two projects.

Table 2. PROFESSIONAL STAFF SUMMARY (Continued).

Individual	CRSP Function	FIELD(S) OF SPECIALIZATION				Location of Work[1]
		Research Admin.	Limnology/ Water Quality	Fisheries Aquaculture	Data Management	
Dr. Romeo D. Fortes	H.C. Research Associate		•	•		Diliman, Quezon City, The Philippines
Mr. William Coops	Administrative Advisor	•				Honolulu, HI
RWANDA - OREGON STATE UNIVERSITY PROJECT						
Dr. Richard A. Tubb	U.S. Co-Principal Investigator			•		Corvallis, OR
Dr. Carl E. Bond	U.S. Co-Principal Investigator			•		Corvallis, OR
Dr. Valens Ndoreyaho	H.C. Principal Investigator			•		Butare, Rwanda
Dr. Boyd Jay Hanson	U.S. Research Associate		•	•		Butare, Rwanda
Mr. Felicien Rwangano	H.C. Research Associate			•		Butare, Rwanda
Mr. William Millison	Administrative Adv.	•				Corvallis, OR
THAILAND - UNIVERSITY OF MICHIGAN PROJECT						
Dr. Karl F. Lagler	U.S. Co-Principal Investigator		•	•		Ann Arbor, MI
Dr. James S. Diana	U.S. Co-Principal Investigator			•		Ann Arbor, MI
Dr. Thiraphan Bhukaswan	H.C. Principal Investigator			•		Bangkok, Thailand
Dr. C. Kwei Lin	U.S. Research Associate		•	•		Bangkok, Thailand

[1]Denotes primary work location and excludes host country site visits and travel for attendance of meetings.

Table 2. PROFESSIONAL STAFF SUMMARY (Continued).

Individual	CRSP Function	FIELD(S) OF SPECIALIZATION				Location of Work[1]
		Research Admin.	Limnology/ Water Quality	Fisheries Aquaculture	Data Management	
Mr. Sompong Hiranywat	H.C. Research Associate			•		Bangkok. Thailand
Mr. Somport Inkatawewat	H.C. Research Associate			•		Bangkok, Thailand
Dr. William Chang	Technical Advisor			•	•	Ann Arbor, MI
Dr. Panu Tavarutmaneegul	Assoc. Researcher			•		Bangkok Thailand
Mr. Nelson Navarre	Administrative Advisor	•				Ann Arbor, MI

[1]Denotes primary work location and excludes host country site visits and travel for attendance of meetings.

4. FINANCIAL STATEMENT

This section summarizes the expenditure of AID and non-federal funds for CRSP research projects and program management. This unaudited summary is intended to provide an overview of CRSP progress relative to budgeted amounts indicated in the CRSP grant.

The AID funds expended relative to amounts budgeted for various program activities are presented in Columns A and B of Table 3. The data on expenditures for research projects were provided by the Principal Investigators of the several projects. The information on Management expenses was taken from monthly account status reports of the Program Management Office.

Because there is typically a time lag between the dates that expenses are incurred and posted, it is likely that the expenditures reported for the Collaborative Research Projects underestimate the true account status. Nonetheless, the projects have expended on the average 94 percent of AID funds obligated during the three year period. It is probable that the accounts are in fact fully expended.

Expenditures for Program Management exceeded the budget during the first three years. This resulted mainly from unbudgeted expenses incurred in conducting the Triennial Review. Guidelines for Triennial Review and responsibilities of External Evaluation Panels have undergone substantial evolution subsequent to the planning of this CRSP. Compliance with recent guidelines have understandably resulted in an increasing administrative and financial burden to the CRSP. The deficits will be absorbed in subsequent year's budgets.

The monthly rates of expenditure have increased throughout the life of the CRSP as the research effort has intensified and elements of the CRSP have become fully implemented. The monthly rate for the final six months of the third year is approximately $115,000 per month, slightly exceeding the linear rate for a program that is projected to be level funded at $1.3 million per year. Reducing and stabilizing the present rate will require reducing funding for some activities in subsequent years.

Cost sharing contributions from the U.S. institutions is presented in Column C of Table 7. These data reflect continuing institutional commitments to participation in the CRSP. It appears that the amounts reported meet or exceed the 25 percent cost sharing requirement. However, confirmation of this required further accounting because the proportions of the amounts shown in Column B to be excluded in calculating the cost sharing requirements in accordance with the BIFAD. Guidelines must be determined after the fact.

Finally, host country contributions (in U.S. dollars) through the first three years of the CRSP are presented in Column E of Table 3. The data presented in Column E were provided by the Principal Investigators of the several projects. Although host country cost sharing is not required, these data indicate a substantial commitment

TABLE 3
SUMMARY OF AID FUNDS BUDGETED AND EXPENDED, AND U.S. AND HOST COUNTRY CONTRIBUTION

	AID Contribution A Budgeted	AID Contribution B Expended	C U.S. Inst. Contribution	D Total Program Expenditures	E Host Country Contribution
Collaborative Research Projects					
Honduras - Auburn University	$ 239,140	$ 218,494	$ 61,070	$ 279,564	$160,800
Indonesia - Michigan State University	383,296	374,719	108,386	483,105	84,720
Panama - Auburn University	330,048	310,892	80,830	391,722	223,000
Philippines - University of Hawaii	379,835	348,759	102,551	451,310	71,900
Rwanda - Oregon State University	334,426	301,058	49,004	350,062	193,000
Thailand - University of Michigan	303,915	288,859	38,174	327,033	96,000
sub totals	**$1,970,660**	**$1,842,781**	**$ 440,015**	**$2,282,796**	**$829,420**
Program Management					
Management Office	389,873	395,873	N/A	395,873	
Executive Council, Technical Advisory Committee and External Evaluation Panel	39,467	75,499	N/A	75,499	
sub total	**$ 429,340**	**$ 471,372**	**N/A**	**$ 471,372**	
TOTALS	**$2,400,000**	**$2,314,153**	**$ 440,015**	**$2,754,168**	

to participation in the CRSP, especially when the dollar amounts are related to local economies.