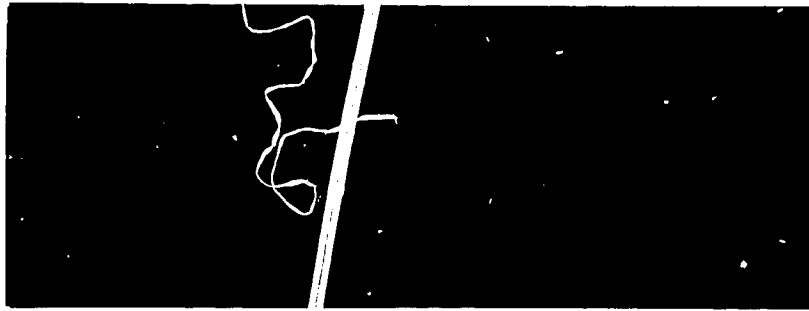


TITLE II
COLLABORATIVE RESEARCH SUPPORT PROGRAM

POND DYNAMICS/AQUACULTURE



**Pond Dynamics/Aquaculture CRSP
Program Management Office
OREGON STATE UNIVERSITY
Marine Science Center
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POANAQ 723

SECOND ANNUAL ADMINISTRATIVE REPORT

December 1984

This administrative report addresses the management and technical accomplishments of the Pond Dynamics/Aquaculture CRSP during the reporting period from 1 September 1983 through 31 August 1984. 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 second operational year of the program has been devoted to carrying out an initial set of standardized pond dynamics experiments at research stations in six Host Countries and to refining the CRSP research plan.

Program Management and Technical Guidance

The program management of the CRSP remained basically the same as reported for the first operational year of the program. The three member Executive Council continued to establish program policy and worked actively to guide the CRSP toward maturity. The three member Technical Advisory Committee again had the lead role in the annual research planning process, which was the focus of a three day meeting of U.S. and Host Country participants held in Atlanta, Georgia on April 10-13, 1984.

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 First Annual Administrative Report, the second CRSP research plan, a series of quarterly newsletters, and an updated program directory. The Program Management Office also coordinated the development of a computerized data base management system, involving the use of a network of micro-computers.

One major addition to the CRSP was the formation of the CRSP External Evaluation Panel. During the reporting period, three individuals were selected to serve on the panel, which will periodically review program accomplishment, progress and prospects.

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 directed efforts to carry out a series of standardized pond dynamics experiments at Host Country research stations. These involved measuring the physical, chemical and biological responses of ponds stocked with tilapia or marine shrimp to applications of prescribed amounts of inorganic fertilizer. Because of disparity in the time required to prepare research facilities at the various sites, rates of progress varied among the implemented projects as summarized below:

The Honduras - Auburn University project team completed the dry season phase of the first cycle of standardized pond dynamics experiments and initiated the wet season phase. Special topic research on the effects of turbidity on fish production was planned.

The Indonesia - Michigan State University project team completed the wet season phase of the first cycle of standardized pond dynamics experiments and initiated the dry season phase. Fish production values were lower than expected at this site, possibly due to high levels of pesticides and detergents in the local water supply. A special topic research plan involving the treatment of pond inflow was developed in response to initial research results.

The Panama - Auburn University project team completed both the wet and dry phases of the first cycle of standardized pond dynamics experiments at the marine shrimp research facility in Aguadulce. The standardized research program on ponds stocked with tilapia was delayed while freshwater research facilities were prepared at Gualaca.

The Philippines - University of Hawaii project team completed both the wet and dry phases of the first cycle of standardized pond dynamics experiments. Preliminary research results indicated that pond depth may be an important factor influencing the productivity of fish ponds.

The Rwanda - Oregon State University project team devoted the first and second operational years of the program to rehabilitating research ponds and preparing new facilities at the national experiment station in Butare. During the reporting period, the resident U.S. Research Associate also worked to obtain suitable strains of tilapia, taught an aquaculture course and conducted preliminary aquarium experiments.

The Thailand - University of Michigan project team completed the dry season phase of the first cycle of pond dynamics experiments at the Nong Sua station. Operations were then moved to the Ayutthaya Research Station, where research facilities are better. The wet season phase of the first cycle was initiated at this new research station. As a result of preliminary experiments, CRSP researchers planned to undertake special topic research on the effects of phosphorus dosage rates on pond productivity.

At the second annual research planning workshop, held in Atlanta, Georgia in April 1984, 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 second 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. CRSP researchers found that local conditions had a substantial effect on the results of fertilization experiments. Thus, the second CRSP research plan provides for special topic research in addition to the standardized program of pond dynamics experiments.

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, 21 are in residence within the participating Host Countries.

FINANCIAL STATEMENT

A cumulative total of \$1,400,000 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 \$1,192,217. Participating U.S. institutions expended a total of \$274,190 in non-federal funds in the performance of CRSP activities, exceeding 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 \$605,790 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.

BACKGROUND

Aquaculture was identified by BIFAD as an important target area for Collaborative Research Support Program activities in 1977. As a first step in initiating an Aquaculture CRSP, AID contracted in 1977 with Resources Development Associates of Los Altos, California to complete a planning study for a fisheries and aquaculture CRSP. Resources Development Associates submitted the findings of its planning study to the Joint Research Committee (JRC) of the BIFAD in August 1978. Among other priorities identified in this report, investigation of the principles and mechanisms of pond culture systems was recommended as an appropriate CRSP area with a high probability of increasing food fish production in the LDCs. In response to this recommendation, AID through the BIFAD, initiated further development of an aquaculture CRSP.

In February 1980, the JRC announced its selection of Auburn University, the Consortium for International Fisheries and Aquaculture Development (CIFAD), and the University of California in Davis to participate in this CRSP. CIFAD is composed of the University of Arkansas at Pine Bluff, the University of Hawaii, the University of Michigan, Michigan State University, and Oregon State University, which serves as the lead institution. At a meeting of university, AID and JRC representatives on 22 February 1980, it was recommended and later approved by the JRC that these institutions would participate in a tripartite management of the CRSP, and that Oregon State University would be designated as the lead agency in the management of the program. At this same meeting the participants were instructed to prepare a preliminary proposal for the CRSP to be presented to the JRC at its meeting in June 1980.

The approach taken in the development of this CRSP was to accomplish a review and synthesis of the state-of-the-art of pond aquaculture and to undertake overseas site visits to determine research needs in the LDCs and to negotiate provisional administrative agreements with potential collaborating institutions. The findings from the state-of-the-art survey and the site visits were translated into planning guidelines to prepare the CRSP work plan and to develop a financial plan for the CRSP. This proposal was submitted to and approved by the JRC on 16 November 1981. AID subsequently 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 project location.

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 second Annual Administrative Report is to summarize program management activities and technical accomplishments during the period from 1 September 1983, through 31 August 1984.

PROGRAM OBJECTIVES DURING THE REPORTING PERIOD

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

- Initiate and/or complete the standardized experiments described in the *CRSP Work Plan: First Experimental Cycle*.
- Develop the work plan for the second experimental cycle, including continuation of standardized experiments at all locations and site specific special topics research.
- Implement the second work plan upon completion of the first cycle of experiments.

ORGANIZATION OF THIS REPORT

The remainder of this report is presented in three chapters. Chapter 2, summarizes the administrative and technical accomplishments of the second 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

Whereas the first operational year of the CRSP was dedicated mainly to implementing the various CRSP activities, CRSP research has been the dominant theme during this reporting period. The program management and research activities of this period are summarized in this section.

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 First Annual Report. The Program Manager and his staff, representing the Management Entity, continued to work with the Executive Council and the Technical Advisory Committee to guide the CRSP in areas of policy, budget management and technical performance. One major addition in the area of management and technical guidance was the formation of the CRSP External Evaluation Panel. This group, which will conduct periodic impartial reviews of the program, is an essential part of efforts to ensure that CRSP research remains carefully directed and cost effective.

Executive Council

As the primary policy making body for the CRSP, the Executive Council has taken an active role in guiding the program toward maturity. The membership of the Council has remained the same since its inception. The three members, each representing one of the major institutional participants in the program, are:

Dr. Alfred M. Beeton
(Chairman of the Council)
Director, Great Lakes & Marine Waters Center
University of Michigan

Dr. Wallis H. Clark, Jr.
Professor of Animal Science
University of California at Davis

Dr. E. W. Shell
Head, Department of Fisheries and Allied Aquacultures
Auburn University

During the reporting period, the Executive Council held five conference call meetings, convened a one-day budget meeting in Phoenix, Arizona in February 1984 and met during a three-day research planning workshop in Atlanta, Georgia in April 1984. This is a substantial increase in activity compared to that during the first operational year of the program. Actions taken by the Council at these meetings include:

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

- Review of fiscal reports and advisement of the Management Entity regarding the apportionment of the limited funds available for program activities.
- Guidance of efforts to strengthen CRSP projects by fostering special topic research at host country sites and at U.S. institutions.
- Selection of members of the External Evaluation Panel for the CRSP.
- Guidance in the development of a centralized CRSP data management system.

Technical Advisory Committee

The Technical Advisory Council advises the Executive Council 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 & 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 second year of CRSP activities. The Committee met with the Executive Council and the Project Manager in late February 1984 to finalize plans for the Annual CRSP Research Planning Workshop. The Workshop was held in Atlanta, Georgia on April 10-13, 1984. At the meeting, 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. About a month after the meeting, the Technical Advisory Committee met once more to incorporate the Research Team's comments in a draft version of the *CRSP Work Plan: Second Experimental Cycle*.

Program Management Office

The Program Management Office provides executive linkage between the Management Entity and operations under the CRSP. As in the case of the

Executive Council and the Technical Advisory Committee, the personnel of the Management Office remained the same as reported in the First Annual Administrative Report. The staff includes:

Dr. James E. Lannan, Program Manager (0.5 FTE)
 Ms. Michele Leslie, Assistant Program Manager (1.0 FTE)
 Ms. Anne Kapuscinski, Graduate Research Assistant, Data Base Management (0.5 FTE)
 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:

- Direction of efforts to secure adequate funding for CRSP activities.
- Monitoring of CRSP budget and preparation of subcontract modifications extending funding and performance period.
- Attendance of AID Program Managers' Meetings, to voice the concerns and needs of CRSP participants and to stay informed of changes in AID policy.
- Facilitation of communication among CRSP participants, through development of an electronic mail system and publication of a quarterly newsletter.
- Arrangement of and participation in meetings of the Executive Council and the Technical Advisory Council.
- Synthesis of the results of meetings and workshops including finalization of the CRSP work plan for a second cycle of experiments.
- Assistance in obtaining travel clearances for CRSP personnel.
- Assistance in obtaining administrative approvals for the purchase of equipment for country projects.
- Development of a computerized data base management system, involving the use of a network of microcomputers to link Host Country project sites, participating U.S. institutions and the Program Management Office.

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 second operational year of the CRSP. These are briefly described below.

First Annual Administrative Report. Pond Dynamics/Aquaculture CRSP, Program Management Office, December 1983. First Annual Administrative Report. Oregon State University, Marine Science Center, Newport, Oregon.

This 34 page report addresses the management and technical accomplishments of the CRSP during the reporting period from 1 September 1982 through 31 August 1983. Included are a statement of program objectives, a description of the efforts undertaken to initiate 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 1984. CRSP Work Plan: Second Experimental Cycle. Oregon State University, Marine Science Center, Newport, Oregon.

This document is a refined version of the initial CRSP Work Plan, which was produced during the first operational year of the program. CRSP participants met in Atlanta, Georgia on April 10-13, 1984, and recommended a number of changes in experimental approach, sampling and analytical protocol, and data management. Key modifications include an expansion of tilapia experiments to include testing the effects of pond applications of organic fertilizers (the initial work plan called only for the application of inorganic fertilizer); and the addition of a provision for special topic research, which would address site-specific research issues.

Updated CRSP Directory. Pond Dynamics/Aquaculture CRSP, Program Management Office, June 1984. CRSP Directory. Oregon State University, Marine Science Center, Newport, Oregon.

The CRSP Directory was initially published during the first operational year of the program. This updated version was prepared to account for subsequent changes in program personnel.

CRSP Newsletter. Pond Dynamics/Aquaculture CRSP, Program Management Office, 1983-1984. 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 Manager, and brief articles and notes on various aspects of the program. The newsletters were distributed to CRSP participants, AID and BIFAD representatives, and to interested persons upon request. AID also was provided 100 copies of the first two issues and 130 copies of the third and fourth issues for internal and overseas distribution.

CRSP Data Management System

Early in the development of the CRSP, it was determined that the use of a standardized research plan at the various CRSP project sites meant that the resulting data could be processed best using a centralized data management system. Toward this end, a network of APPLE IIe microcomputers was created, linking the participating U.S. institutions, project sites and the Program Management Office. A key task during the reporting period was to develop suitable data management software for this system.

An initial plan for the CRSP Data Management System was developed by Mr. James Buston of Auburn University. The proposed system involved the use of the commercially available software package, "The General Manager", produced by Sierra On-Line, Inc. of Coarsegold, California. Mr. Buston developed a tailored format or "menu" diskette to be used with "The General Manager" hierarchical data base and prepared a brief working paper to facilitate data entry and retrieval.

The Auburn data management plan was presented at the Second Annual CRSP Research Planning Workshop. Although some program participants felt that a different type of system would be preferable, it was decided that "The General Manager" system would be implemented on a trial basis. Copies of the program were purchased for use at project sites and at U.S. institutions involved in the CRSP projects. The Program Management Office refined the software and the guidance manual produced at Auburn University and sent copies of these materials to CRSP participants in July 1984.

During the reporting period, Research Associates in residence at the CRSP project locations began using "The General Manager" system to store the results of their standardized pond dynamics experiments. At the Program Management Office, work was undertaken to develop a centralized data storage system, by transmitting data files from a microcomputer to a mainframe computer located at Oregon State University. The success of the system will be evaluated during the Third Annual CRSP Research Planning Workshop, scheduled for March 1985.

External Evaluation Panel

The External Evaluation Panel, 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 Executive Council and approved by the Joint Committee on 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 were nominated to serve on the External Evaluation Panel:

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

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

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

On May 15, 1984, the JCARD approved the appointment of these candidates to the panel. The JCARD noted however, that "added strength in vertebrate aquaculture, economics, and LDC experience is needed on the EEP." In response to this concern, the CRSP Executive Council reopened its process of candidate selection. This process was not completed during the reporting period and no meetings of the approved panel members were held.

RESEARCH ACTIVITIES

Six collaborative research projects had been fully implemented at the beginning of 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 second cycle of experiments concurrently so that the several projects should be more closely synchronized in the foreseeable future.

The following project summaries have been excerpted from the project Principal Investigator's periodic activities reports to the Program Management Office.

HONDURAS - AUBURN UNIVERSITY PROJECT

U.S. LEAD INSTITUTION

Auburn University

U.S. PRINCIPAL INVESTIGATOR

Dr. Ron Phelps

Table 1. SUMMARY OF PROGRESS FOR CRSP PROJECTS

| COUNTRY | CYCLE I | | CYCLE II | | SPECIAL PROJECTS |
|-------------|---|--|------------------|-----|--|
| | DRY | WET | DRY | WET | |
| | | | | | (Tilapia Studies) |
| Honduras | Completed 6/84 | In Progress - to be Completed 12/84 | Will begin 2/85 | | Turbidity management |
| Indonesia | In Progress - to be Completed 10/84 | Completed 4/84 | Will begin 12/84 | | Water conditioning |
| Panama | Will begin 1/85. Cycles I and II to be done concurrently. | | | | |
| Philippines | Completed 7/84 | Completed 12/83 | Will begin 1/85 | | Effect of pond depth or plankton community |
| Rwanda | Will begin 1/85. Cycles I and II to be done concurrently. | | | | None at present |
| Thailand | Completed 7/84 (Nong Sua Station) | In Progress - to be Completed 12/84 (Aytthaya Station) | Will begin 2/85 | | Dosage rates for phosphorus in ponds |
| | | | | | (Shrimp Studies) |
| Panama | Completed 5/84 | Completed 12/83 | In Progress | | |
| Philippines | Will begin 1/85. Cycles I and II to be done concurrently. | | | | Pond renovation underway |

HOST COUNTRY LEAD INSTITUTION

Directorate of Renewable Natural
Resources (RENARE)
Ministry of Natural Resources

HOST COUNTRY PRINCIPAL INVESTIGATOR

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 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 Comayaqua Aquaculture Station were reserved for CRSP activities, and basic needs for equipment and supplies were identified.

RESEARCH ACTIVITIES

During the period September 1, 1983 to August 31, 1984 considerable progress has been made in increasing research capabilities at the Comayaqua station. A laboratory has been installed and a staff has been trained to conduct CRSP analyses. The dry season phase of the first cycle of CRSP experiments has been completed. Fish production values in this study were considerably lower than anticipated, probably due to high turbidity levels. The influence of turbidity was reflected in low secchi disk readings and little diurnal change in dissolved oxygen concentrations and associated photosynthetically related water quality parameters.

The wet season phase of the first cycle of experiments was initiated on July 11, 1984 and is scheduled to end December 10, 1984. Technical problems, related to inadequate concentrations of Chlorophyll a in collected samples, have been encountered during the performance of this work. Difficulties also have been encountered in being able to conduct light/dark bottle studies in all 12 ponds in a similar time frame.

The low levels of fish production obtained in the dry season phase of the first cycle CRSP study indicated that alternative pond management practices should be considered. A polyculture study using organic manures and feed was conducted to see what yield might be anticipated with more intensive management practices and whether turbidity continued to be a problem. The experimental phase of this study ended in late September. The data currently are being analyzed.

A comparison of the growth of male *T. nilotica* and male hybrid *T. nilotica* x *T. hornorum* was made using a locally available 23% protein pelleted feed. After a 90-day culture period there was no significant difference in growth or survival between the two groups of fish. Net

production was 1,197 kg/ha for male *T. nilotica* and 1,143 kg/ha for male hybrids. The feed conversion ratios were 1.04:1 and 1.12:1, respectively.

During the period from October 1983 to March 1984, several tilapia fingerling production studies were conducted in hapas and concrete tanks. The fingerling yields were less than expected in all studies. A major factor thought to influence the yields was the relatively low water temperatures for tilapia reproduction. Water temperatures during the period of these studies ranged from 21 to 25°C.

OTHER RESEARCH ASSOCIATE ACTIVITIES

Approximately 85% of U.S. Research Associate Bart Green's time has been devoted to the above mentioned research activities and 15% to related service activities. The following are examples of the various service activities. Lectures were given for 2 1/2 days on water quality, integrated aquaculture and pond construction for 28 assistant extension agents during a four day aquaculture course. Lectures were given in three separate training courses to RENARE inspectors on integrated aquaculture. A presentation was given to the curriculum committee of the Ministry of Education regarding technical school programs in fisheries and aquaculture. Mr. Green and Host Country Research Associate Hermes Alvarenga participated in a Peace Corps fisheries program evaluation and planning meeting. They reviewed current practices and recommended future activities. Mr. Green participated in an inter-ministerial meeting for coordinating aquaculture activities and developing a national plan. Assistance has been given to RENARE staff in developing policy regarding fingerling production and distribution. A field day was organized which the Minister of Natural Resources, the AID Mission Director and staff of the OET and Agriculture Offices attended. An executive committee was organized within RENARE to advise the CRSP program regarding research needs as seen from the field and to serve as a vehicle for creating within the government an awareness of the CRSP program. The above mentioned items are only examples of Mr. Green's activities, more day to day activities included supervising students and giving assistance to other station activities.

Mr. Green, along with Lic. Jonathan Espinoza and Dr. Ron Phelps, the Host Country and U.S. Principal Investigators for the project, attended the CRSP planning and review meeting held in Atlanta, Georgia. These individuals participated in developing the next CRSP work plan. Dr. Phelps traveled to Honduras to attend a meeting of project participants. Future project activities and steps toward conducting the second cycle of CRSP experiments were discussed during this meeting.

FUTURE ACTIVITIES

The second cycle of CRSP experiments are scheduled to start in January 1985. Additional investigations into the effects of turbidity of fish production also are planned. A frequent sampling program of both inorganically and organically fertilized ponds will be conducted to note changes in total suspended solids, total volatile solids and secchi disk readings. A dye will be added to the pond bottom to better understand the degree of mixing within the pond.

Several approaches for increasing the efficiency of the station in the production of the monosex tilapia cultures used in the extension program will be studied. Presently the major portion of the Comayaqua station is devoted to fingerling production. It is hoped that new management practices can be developed to increase the efficiency of the station and provide additional pond space for other research activities.

INDONESIA - MICHIGAN STATE UNIVERSITY PROJECT

U.S. LEAD INSTITUTION

Michigan State University

U.S. PRINCIPAL INVESTIGATOR

Dr. C. D. McNabb

HOST COUNTRY LEAD INSTITUTION

Institut Pertanian Bogor (IPB)

HOST COUNTRY CO-PRINCIPAL INVESTIGATORS

Dr. M. Eidman
Dr. Kusman Sumawidjaja

POND CULTURE 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). 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. There twelve fish culture ponds are utilized for CRSP activities. During this reporting period the research site was prepared, the first experiment (wet season) was completed and the second experiment (dry season) was initiated and nearly completed. The second experiment is due to be finished on November 14, 1984. Total host country contributions during this reporting period amounted to \$22,000 U.S.

RESEARCH ACTIVITIES

Dr. C. D. McNabb (U.S. Principal Investigator) and Dr. Bette J. Premo (U.S. Research Associate) arrived in Indonesia on August 30, 1983. During their first two weeks in the country, significant events occurred that improved the condition of the CRSP research site at Darmaga Field Station (DFS) of Institut Pertanian Bogor (IPB). Electricity was connected to the main buildings, running well water connected into the laboratories and the 1/2 kilometer dirt road from the main drive to the research site (previously navigable only with 4 wheel drive) was repaired and paved.

During the next four weeks the DFS ponds were readied for experiments. Twelve ponds were deepened to achieve the specified depth of 90 cm when full of water. The outlet and inlet pipes were repaired and fitted with mesh screen to prevent fish from entering or escaping. A metered rule was painted on the cement structure near the outlet of each pond so that depth of water in the ponds could be read at a glance. Docks made of bamboo were constructed for each pond so that researchers could sample from the center of the ponds without disturbing the pond bottom. All labor costs for this work were incurred by IPB.

Three rooms were made available in the main building at DFS for CRSP research activities. These rooms were cleaned and painted. A refrigerator, glass cabinets, metal racks and formica topped tables were supplied by IPB. Some of the equipment from the U.S. required the use of power stabilizers and converters so these items were purchased in-country.

After the DFS ponds were dug, sediment samples were taken from each. Part of these samples was sent to Oregon State University Soil Testing Laboratory for analysis in accordance with the CRSP work plan.

Another part of the samples was dried and used to run SMP-Lime Requirement at IPB in order to obtain results and begin experiments in an expeditious manner. After the time requirement was determined, fine-ground CaCO₃ was purchased and was evenly distributed on the dry pond bottoms. Several days after that the ponds were filled with water. Fertilizer was added to the ponds two weeks after liming.

Other pond preparations included installing rain gauges on the docks of three of the ponds, and in each of three ponds two maximum-minimum thermometers were placed; one at depth 25 cm below the surface and one at depth of 25 cm above the pond bottom. Just prior to beginning the experiments, water samples were taken from each pond and from the incoming water and were sent to Michigan State University Limnology Research Laboratory for analysis in accordance with the CRSP Work Plan.

Tilapia nilotica were purchased from a nearby fish hatchery in Sukabumi at size between 25 and 50 grams each. All fish were individually identified as *Tilapia nilotica* and individually sexed at the Darmaga CRSP site. The initial stock of each pond was weighed as a group (200 fish). The ponds were stocked with male fingerlings on October 31, 1983. The first experiment was completed on March 23, 1984.

The second experiment (dry season) began in June, 1984, and during April and May, ponds and methods were prepared. As of April, all necessary equipment, chemicals and supplies were received in country and installed at the Darmaga research site in order to carry out the full complement of suggested measurements. In this experiment levels of nitrite, nitrate, ammonia, Kjeldahl nitrogen, and total ortho-phosphorus were measured. A laboratory manual was completed which was used by Indonesian technicians working in the CRSP limnology laboratory. The manual includes methods for all analyses, example data sheets, and a schedule of required activities. A copy of this manual was sent to the Program Management Office.

In compliance with a CRSP Executive Committee request, Dr. C.D. McNabb recommended that some of the experimental ponds be lined with cement to eliminate seepage problems. During May, four pond bottoms were deepened and a cement lining was laid and attached to the existing cement sides of the ponds. This job was done to ensure that at least four ponds would retain water during the dry months. The seepage problem was eliminated in the four cemented ponds and was significantly lessened in the others with some careful repair of the outlet structures. Other activities during the month of May included sampling the bottom soil of all ponds and determining lime requirement as well as shipping soil samples to Oregon

State University's Soil Testing Laboratory for analysis. Pond bridges were strengthened, *Tilapia nilotica* fingerlings ordered, and laboratory materials were checked and readied.

On June 2, ponds were limed according to the recommendations received by Institut Pertanian Bogor Soil Sciences Laboratory. In general, the ponds required less lime for the second experiment than for the first. Presumably, traces of lime from the first treatment of November 1983 still remained in the soil.

On June 6, all ponds were fertilized using triplesuperphosphate which was 46% P205. This fertilizer was from the same lot as that of experimental run #1. The rate of fertilization was calculated as 0.35 kg TSP/each pond/month in order to achieve the prescribed rate of 8 kg P205/hectare/month.

During the week of June 11-16 water chemistry analyses were begun including the measurement of diurnal dissolved oxygen, pH and temperature, chlorophyll a, alkalinity, hardness and turbidity. Measurements of physical parameters were also initiated including rainfall, evaporation, maximum-minimum air and water temperatures and pond depth. Water samples for more complete analyses of anions and cations were taken and shipped to MSU Limnology Laboratory on June 14.

On June 19, *Tilapia* fingerlings were stocked in the ponds. Twenty fish from each pond were individually weighed and length was measured and the total 200 from each pond were weighed as a group. Initial mortality of the newly stocked fish was very low.

Results from the first experiment (wet season) were communicated to the Program Management Office in CRSP Project Report I (March 1984). Climatological measurements taken during this period included: daily maximum-minimum air temperatures from Bogor, biweekly maximum-minimum air temperatures from Darmaga, daily rainfall readings from Bogor, biweekly rainfall readings from Darmaga, daily windspeed readings from Bogor and daily light readings from Bogor. Pond chemistry and hydrology measurements taken during this period included: weekly measurements of dissolved oxygen and pH in all twelve ponds and maximum-minimum water temperatures in three ponds, biweekly measurements of secchi depth, monthly measurements of change in dissolved oxygen and pH over a diurnal period, monthly measurements of alkalinity and hardness, and daily readings of pond depth. Biotic parameters in the data set included weekly determinations of chlorophyll a, average weight of subsamples of *Tilapia* over the period of the experimental run, and qualitative lists of phytoplankton, zooplankton and benthos organisms in the CRSP ponds.

The second experiment (dry season) will be completed on November 14, after which completed tables will be compiled and sent to the Program Management Office. During November, CRSP Research Associate, Dr. Bette J. Premo, will enter all the data from the first and second experiments on computer data diskettes using the specifically developed "General Manager" system and will then submit the diskettes to the Program Management Office.

Results from both the first and second experiments have demonstrated very low production of fish. Water quality parameters which were measured such as dissolved oxygen, temperature, pH, alkalinity, hardness, nutrients and chlorophyll a showed adequate conditions for fish growth. The investigators believe there are some as yet unmeasured factors which are reducing pond productivity in this and other aquaculture systems of Indonesia. Two potential detrimental factors are detergents and pesticides which are heavily used and carried by the surface waters. These factors will be specifically investigated in year-3 studies.

OTHER ACTIVITIES ACCOMPLISHED UNDER THE PROJECT

In order to facilitate research activities and at the same time involve students in the CRSP program, Dr. M. Eidman, Dean of the Faculty of Fisheries at IPB and Host Country Principal Investigator, suggested the involvement of five undergraduate students with the First Experimental Cycle. These students are just finishing their undergraduate degrees in fisheries and are required to complete a thesis project in their field. Dr. Eidman and Dr. Premo advised the students on project topics and currently they are completing their work. Gadis Sri Haryani is determining the growth rate, mortality and feeding habits of the *Tilapia* used in the CRSP project. Ida F. Suratman is doing her thesis project on the composition, abundance and diversity of zooplankton in the CRSP ponds. Sampling and analysis of chlorophyll a is being carried out by Slamet Subyakto. Liliek Litasari is determining composition, density and diversity of macrobenthos and Mr. Widjaja is analyzing data related to hydrology such as determining seepage rates and residence time of water in the CRSP ponds. Three of the students took the extra effort to write their thesis proposals in the English language. These proposals are included in the CRSP Project Report I (March 1984). Besides their own projects the students assisted with routine analyses of other physical and chemical parameters of the CRSP ponds.

New water chemistry methods were successfully carried out at the Darmaga Fisheries Laboratory during the second experiment. Two technicians were hired to assist in and learn these methods including analyses of total dissolved and total dissolved reactive phosphorus, nitrite, nitrate, ammonia and Kjeldahl nitrogen. The technicians are staff members of the Faculty of Fisheries at IPB and have expressed a long term commitment to the CRSP Aquaculture projects. The technicians are utilizing the laboratory manual compiled by Dr. Bette J. Premo. At present, Mr. Komar Sumatadinata is completing the translation of this manual into the Indonesian language so that it can be more easily utilized by undergraduate students as well as staff members.

Other activities have revolved around the CRSP program. The CRSP-Indonesian project has been instrumental in developing standardized data sheets which have been adapted for use at all the CRSP Aquaculture sites and the MSU Limnology Laboratory helped to develop the experimental protocol and methods for the Second Experimental Cycle. Dr. C. D. McNabb presented information from the CRSP site at the Annual Meeting of the Michigan Academy of Science, Arts and Letters in Big Rapids, Michigan in

March 1984. The title of his paper was "Light incident on temperate and tropical lakes and ponds" and includes as authors C. D. McNabb, B. J. Premo, T. R. Batterson and J. R. Craig. MSU Department of Fisheries and Wildlife hosted Mr. Aziz from the Faculty of Fisheries of Institut Pertanian Bogor during July. Mr. Aziz was visiting U.S. universities and learning about microcomputer applications for fish population studies.

The overall effect of the CRSP program has been a very positive one for Institut Pertanian Bogor. The Rector of the University, Dr. Andi Hakim Nasoetion, has stated that this is the most successful fisheries program that IPB has had. As a result of the active research program established at Darmaga, several new buildings have been promised by the University administration for the site. University classes in limnology are now being held at Darmaga for practical field experience and students have the opportunity to use previously unavailable equipment. Many students are now interested in being involved with the project for their degree programs and staff members have expressed interest in gaining expertise in some of the water chemistry methods. In response to a questionnaire from AID Washington, IPB was very enthusiastic about the progress and the future of this CRSP Program. There is no doubt that along with the goal of attaining more scientific research data on fish culture, an important side-effect of the Indonesia CRSP Aquaculture program is the increased enthusiasm for freshwater research in general.

PANAMA - AUBURN UNIVERSITY PROJECT

U.S. LEAD INSTITUTION

Auburn University

U.S. PRINCIPAL INVESTIGATOR

Dr. Ron Phelps

HOST COUNTRY LEAD INSTITUTION

National Directorate of Aquaculture
Ministry of Agricultural Development
(MIDA)

HOST COUNTRY PRINCIPAL INVESTIGATOR

Dr. Richard Pretto M.

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 production 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.

RESEARCH ACTIVITIES

During the project period September 1, 1983 to August 31, 1984, research was conducted at stations in Aguadulce, Divisa and Gualaca Panama. The first cycle of CRSP experiments was completed for both the rainy and dry seasons at the brackishwater station in Aguadulce. A mean shrimp production in the rainy season was 173 kg/ha and 228.3 kg/ha during the dry season. Several other pond studies were being conducted in parallel with the CRSP studies, both in the rainy and dry seasons. A shrimp-fish polyculture was studied and the results indicated that the presence of fish had no effect on shrimp growth or survival. A comparison of the shrimps *Penaeus vannamei* and *P. stylirostris* in mono- and polyculture, with and without feed was made. *Penaeus vannamei* gave a better production in an unfed monoculture than *P. stylirostris*. When given a commercial feed *P. stylirostris* gave a better production. In polyculture the presence of *P. vannamei* reduced the growth and survival of *P. stylirostris*.

A study was conducted to evaluate several alternatives to reduce the need for commercial shrimp rations. In three treatments, half the protein equivalent of the commercial ration was replaced by either a cow manure, chicken manure or chopped fish source. In a fourth treatment, a full ration of commercial feed was given.

The best production and survival was obtained when only the commercial ration was given. The average sizes of shrimp produced when manure was applied was similar to that of the full commercial ration but the survival was less.

The second cycle CRSP study has begun using both inorganic and organic fertilizers. The wet season portion of this study will end in November, 1984.

The Divisa station has concentrated its efforts on improved seed production techniques. A comparison of three tilapia fry production systems was conducted to determine the system most appropriate for producing 9-12 mm fry. The three systems were (1) partial harvest of fry twice a week over a six week period and final complete harvest; (2) fourteen day partial harvests from net hapas; (3) partial harvests of fry twice a week with complete harvest every 15 days into a catch basin with flowing water. The most cost effective system was the third treatment.

Fry produced in the above rearing systems were cultured intensively to a size suitable for stocking into nursery ponds. Groups of fry were fed either a 25% protein feed or a 44% protein feed and fed at one of three different feeding rates. After 20 days of feeding there was no statistically significant difference in average weights or feed conversion between treatments.

Stocking density of fry significantly influenced the size of fingerlings available for stocking into nursery ponds. A study was conducted to determine the effect of stocking density. After 26 days the average gains were 0.69 g, 0.73 g and 0.53 g, respectively, for the stocking densities of 333, 416, and 500 fish/m². Low oxygen was a factor limiting growth at the 500 fish/m² density.

The major portion of the freshwater CRSP activities in Panama will concentrate at the Gualaca Station. This station has become operational during the last year. Ponds were first available during the middle of the 1984 dry season. A three-month study was conducted in the remaining portion of the dry season following the CRSP protocol. These results are now being processed as part of student theses. A wet season, first cycle CRSP study was begun July, 1984 but terminated early due to technical problems.

A polyculture study is in progress using six different combinations of either tilapia, *Colossoma*, silver carp and freshwater shrimp. This study is being conducted as part of the CRSP activities with students collecting data on fish production, water quality and plankton populations.

A study comparing the effect of liming is underway. Three ponds were limed to meet the requirements specified in the CRSP protocol while three remained unlimed. Water quality sampling are being conducted for both treatments following the CRSP protocol.

OTHER CRSP ADVISOR ACTIVITIES

A major portion of David Hughes time has been devoted to a variety of training activities. Seminars have been presented to university students, commercial shrimp producers, government extension agents and biologists, and AID officials on subjects that included: the nature of the CRSP program, shrimp culture, feeds and fertilizers, water and pond management, and water chemistry. Thirteen students' research programs have been directed. Approximately 40 hours of computer training has been offered to MIDA staff. Approximately 30 meetings have been held with the CRSP staff reviewing CRSP procedures and methodology.

Monthly planning meetings were held with Dr. Pretto and his planning staff regarding the upcoming activities, while weekly planning meetings were held with station staff. A significant portion of David Hughes time has been devoted to assisting in the equipment purchasing process for the laboratories to be furnished by AID.

An invited paper was given at a National Symposium on Aquaculture in Costa Rica regarding the evaluation of tilapia fry production procedures. Mr. Hughes attended the CRSP review and planning meeting held in Atlanta, Georgia. A review of 1984 activities and planning of 1985 activities was held with the Auburn principal investigator in Panama in September 1984. At that time reporting procedures were discussed along with budget allocations for 1985 and future research activities.

FUTURE ACTIVITIES

Aguadulce Station

In addition to completing the dry season phase of the second cycle, future activities at the brackish water station will concentrate on the

practice of daily water exchange and its role in shrimp production. Pumping costs are one of the major costs in shrimp production in Panama but little data is available on true rates of exchanges now practiced in the industry or the contribution of water exchange to shrimp production. Another area of investigation will be feeding practices and feed quality.

Divisa Station

Continued efforts will be made at Divisa to develop techniques to optimize tilapia fingerling production. Increased attention will be given to sex reversal procedures.

Gualaca Station

The major effort at the Gualaca station will be directed toward completing the first and second cycle CRSP work plan. The low soil pHs and low water alkalinities at the Gualaca station present conditions that may be subject of many future research activities. Additional attention will be given in the future toward *Colossoma* investigations.

PHILIPPINES - UNIVERSITY OF HAWAII PROJECT

U.S. LEAD INSTITUTION

University of Hawaii

U.S. PRINCIPAL INVESTIGATORS

Dr. Philip Helfrich
Dr. Arlo Fast

HOST COUNTRY LEAD INSTITUTION

University of the Philippines in
the Visayas

HOST COUNTRY PRINCIPAL INVESTIGATOR

Dr. Jose A. Carreon

POND CULTURE SYSTEMS INVESTIGATION

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 about 17 kilometers 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 brackishwater ponds. Of these, 18 units of 1,000 sq m ponds are devoted to CRSP baseline research. 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, ten faculty members of the UPV-CF, seven research staff of BAC, one research aide, eight administrative people, three full-time and fourteen 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. All but the three laborers and the driver are full-time, regular employees of BAC.

The Pond Dynamics CRSP in the Philippines developed a research program that was implemented in the first experimental cycle (June-December 1983). Consistent with the technical goals of the CRSP, the CRSP research at BAC was divided into two categories - baseline tasks and special topics.

The baseline tasks at BAC are designed for collecting basic biological, chemical and physical data on ponds stocked with milkfish and tilapia. These tasks satisfy the basic requirement of simultaneously collecting data similar to those being collected at other CRSP sites while providing a basis for new information useful to local aquaculture. Most of these data types have been collected at BAC in the past, but not necessarily simultaneously. Previous BAC data will be used to substantiate the validity of the present results where possible.

The existence of well-equipped aquaculture research facilities and trained personnel at BAC allowed the pursuit of additional researches conceived as having special relevance to CRSP objectives and of interest to the researchers at BAC. The proposed projects ranged from enhancement of the baseline tasks in the same ponds to special projects done in other ponds or aquaria.

The baseline project was implemented during the rainy season at the Brackishwater Aquaculture Center from June to December 1983. 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 for these five months. Before, during and after grow-out, meteorological (general weather conditions, wind speed and direction, air temperature, solar radiation, evaporative potential, relative humidity, rainfall, barometric pressure), soil chemical (wet pH, dry pH, total nitrogen, reactive phosphorous, organic matter, exchangeable iron, exchangeable aluminum), water physical (dissolved oxygen, water temperature, salinity, pH, pond depth, Secchi disk), water chemical (nitrate, nitrite, ammonia, reactive phosphorous, phosphorous), water biological (chlorophyll, plankton, community respiration, lablab standing crop, lablab composition) and fish production (individual length, individual weight, mass weight, yield, survival) variables were measured at specific time and locations from the 18 ponds. These baseline data have been submitted to the Program Management Office. The results were statistically analyzed and graphed as appropriate.

Besides establishing the levels and ranges of these variables, analyses of the results revealed several phenomena. Fish production was correlated with primary productivity. Primary productivity correlated with some soil chemical parameters. All pH values tended to rise over the culture period. Soil pH also correlated with soil iron content. Beyond these, few of the expected correlations were significant. This occurrence pointed up the need to carefully reconsider the sampling techniques (times, location, etc.), which was done for the dry season experiment.

Another interesting, but unconfirmed, phenomenon was the significantly better fish growth in "lablab" (complex benthic blue-green algal mat) ponds where "lumut" (floating filamentous green algal raft) also happened to occur. This occurrence will be tested in subsequent experiments.

One very significant aspect of the CRSP activities in the Philippines is that the objectives of the baseline work are consistent with the overall research programs of the BAC, thus, they support and complement each other.

RWANDA - OREGON STATE UNIVERSITY PROJECT

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|-------------------------------------|-------------------------------------|
| U.S. LEAD INSTITUTION | U.S. PRINCIPAL INVESTIGATORS |
| Oregon State University | Dr. Richard A. Tubb |
| HOST COUNTRY LEAD INSTITUTION | HOST COUNTRY PRINCIPAL INVESTIGATOR |
| National University of Rwanda (UNR) | Dr. Valens Ndoreyaho |

POND CULTURE SYSTEMS INVESTIGATED

Cooler water ponds at medium to higher elevations in Africa.

RESEARCH ACTIVITIES

The Rwandan CRSP project has taken two years to get underway, but the project has developed the personnel, cooperation and facilities to implement the CRSP Work Plan. The CRSP was delayed by lengthy negotiations regarding use of Rwandan research facilities. A final memorandum of agreement was signed on November 12, 1983 and the Rwandan government released the ponds for CRSP use on March 1, 1984. The ponds had to be renovated and Rwanda has used a \$170,000 grant from the European Common Market to renovate the ponds and construct 20 ponds that will be used only for CRSP research. In addition, a small laboratory building has also been constructed adjacent to the ponds.

Pond renovation began in March with 250 laborers placed under the direction of Dr. Boyd Hanson, OSU Research Associate in Rwanda. Dr. Hanson and his team of foremen surveyed the area for the ponds and the water system. The team of foremen used in directing the pond and water system

renovation has also been trained to utilize and care for the research equipment and to make the chemical tests that are a part of the CRSP plan. A Rwandan Research Associate has not been named to date, however the University will formally select one of the foremen to be a research associate in March 1985.

After a long search for a pure strain of *Tilapia nilotica* it was decided that only *T. nilotica* hybrids were left in Rwanda. In May we asked Auburn University to supply a pure strain of *T. nilotica*. Drs. E. W. Shell and D. D. Moss have been most generous in their support and concern for the project and supplied *T. nilotica* immediately at no cost and at great inconvenience. Karen Veverica, an Auburn faculty member in Rwanda, has also provided outstanding cooperation to the CRSP.

The first cycle of experiments for the CRSP will begin on November 1, 1984 almost 15 months late. The delays have been costly but the cooperation, firm commitment and joint dedication to the CRSP have been firmly established. Trained personnel are in place with facilities designed for the CRSP and the prospects for a productive research program that will continue in Rwanda are excellent.

The project delays have not prevented Dr. Boyd Hanson from accomplishing much during the past 15 months. In September a course in biostatistics and aquaculture was taught by Dr. Hanson. Texts were not available and the examples from temperate countries were difficult for the Rwandan students to understand. Dr. Hanson essentially wrote a text while teaching the course. The course also served as a training exercise for University personnel assigned to the CRSP. Although the experimental ponds were not available until March 1, aquarium experiments with *Tilapia nilotica* hybrids found in Rwanda were initiated. Waste products, that are available for fertilizing *Tilapia* ponds, were tested for compatibility with *Tilapia* and the conversion to fish growth.

THAILAND - UNIVERSITY OF MICHIGAN PROJECT

U.S. LEAD INSTITUTION

University of Michigan

U.S. PRINCIPAL INVESTIGATORS

Dr. James Diana
Dr. Karl F. Lagler

HOST COUNTRY LEAD INSTITUTION

Department of Fisheries (DOF)
Ministry of Agriculture and
Cooperatives

HOST COUNTRY PRINCIPAL INVESTIGATOR

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.

Dr. James Diana was appointed Project Director on 30 September 1983, and Dr. Karl Lagler, the former U.S. Principal Investigator, was retained as Co-Principal Investigator.

Thailand participants remain Dr. Kwei Lin (UM Research Investigator), Dr. Thiraphan Bhukaswan (Thailand PI), and Mr. Vikai Sirsuwanatach (Thailand Research Investigator). On site work began in April 1983 at Nong Sua Fish Hatchery, located 120 km northeast of Bangkok. Wet season experiments were not conducted due to extreme flooding, while dry-season experiments began 5 January 1984. These were finished in July 1984. At that time, the experimental site was moved to Ayutthaya, 100 km northwest of Bangkok. Wet season experiments were begun there in late July, and will continue until September.

RESEARCH ACTIVITIES

a) Dry Season Cycle

The field portion for this project was initiated in April 1983 when Dr. Lin began residency in Thailand. Dr. Lin and Mr. Sirsuwanatach directed pond preparation at the Nong Sua Station in June 1983. Twelve ponds, each 800 m² in area, were drained, repaired, and weeded. Depth gauges and sampling platforms were installed. Soil samples were taken and sent to a Thai laboratory for analysis. An additional 3,200 m² pond was prepared for fingerling production. The ponds were filled and drained several times to leach the soils. Lime was added to the fry pond at 3,000 kg/ha, and the pond was flooded and stocked with 40,000 *Tilapia* fry in August. Flooding delayed the initiation of experiments from late October until late December. On 23 December 1983 the experimental ponds were limed at 3,000 kg/ha, flooded, and the ponds were stocked with 500 *Tilapia* each on 5 January 1984. The flooding of late October caused major losses of fry, and therefore several size classes and groups of fry were introduced. Some of the smaller fry were difficult to sex accurately, while the larger fry were reasonably easy to sex.

The experimental ponds were monitored from 5 January to 1 July. Physical data collected to date include soil analysis, precipitation, air temperature, water temperature, and water depth. Due to lack of current information from Thailand, these tables only reflect the period through April 1984. In general, the physical pond parameters showed great consistency. The soils at the site were extremely acidic clay. Precipitation varied considerably, with a monthly high of 916.2 mm, and 8-month total of 2.85 m. Daily rainfall varied from 0 to 346 mm. This total rainfall was the highest for the century, and resulted in several delays and problems.

Water chemistry data included pH, alkalinity, and phosphate. The levels of pH and alkalinity were very low at flooding, but the lime treatment resulted in quick recovery and stable levels in these factors. Phosphate levels rose immediately after fertilization, but dropped to nondetectable levels within 30 days post fertilization.

Biological measurements included chlorophyll a, and fish growth. Chlorophyll a levels paralleled phosphate levels with a slight time lag. Fish growth averaged about 1 g/day, and was confounded by reproduction of *Tilapia* in the ponds. Apparently about 10% of the total fish stocked were females.

b) Departures from Plan for Dry Season

Soil chemistry was analyzed at a local laboratory, due to the high costs of that work elsewhere. Wind and light levels were not monitored, since appropriate equipment was not available. Only 10 ponds were stocked with fish because two ponds never developed phytoplankton blooms in spite of our treatments. The major problem involved stocking of both male and female fish (about 10% females), which resulted from low availability of fry due to flooding.

c) Wet Season Cycle

Because of the difficulties with low pH and flooding, negotiations were finalized to allow use of the Ayutthaya Hatchery for future CRSP projects. This is a new hatchery near the Chao Phaya River, which has better water quality, as well as extensive diking and pumping facilities for flood control. Twelve experimental ponds (500 m² in area) have been allocated for CRSP use, as well as a large broodstock pond (3000 m²) and several concrete holding tanks. Laboratory facilities and housing have also been made available for exclusive use of the CRSP researchers.

Seed production was very good this year, and an excess of fry led to good sexing ability. The fry were sorted by sex twice prior to stocking, to insure unisex culture. The ponds were stocked on 1 August 1984, and wet season experiments will continue through December. In addition, standardized equipment were purchased to allow measurement of wind velocity and light levels, as detailed in the work plan. Also, soil samples have been collected for analysis at OSU.

Thai personnel on site have been hard to maintain, as they generally take this position after graduation from college and soon quit to become employed at the Department of Fisheries. We were contacted by personnel from Malaspina College in Nanaimo, British Columbia. They have been interested in field training for their graduates, and offered to pay travel expenses for someone to work with us if we would arrange local logistics. In August 1984, Kathy Lysack arrived in Thailand and began working on this project. We are paying her at current rates for Thai nationals and expect her participation for one year.

OTHER ACTIVITIES

Due to difficulties in our local conditions, additional research activities were slow to begin. However, Kwei Lin has initiated two additional projects: one on seed production of sand gobies in Thailand, the second on all-female culture of *Tilapia nilotica*.

The first project is cooperative with personnel at Nong Sua Hatchery. The major problem in sand goby production is that the young hatch at a very small size, and are difficult to feed for early growth. The project involves production of unispecific rotifer cultures and blood worm cultures to use for early food. This has been done successfully for several months, and many of the techniques have been clarified. No publications have resulted from this as yet, although presentation of results to the Second International Conference on Warm Water Aquaculture is planned for February 1985.

The second project is again collaborative between personnel at Nong Sua Hatchery, Kwei Lin, and James Diana. It involves culture of all-female *Tilapia*. The motivation behind this is:

- (1) Current practices of unisex culture involve wastage of female fish;
- (2) Males dig nests, even in unisex culture, increasing pond turbidity;
- (3) Females in unisex culture may not grow ovaries, or at least will only grow them once, thereby reducing the growth advantages of males; and
- (4) Females will not dig nests.

Thailand personnel have begun work on all-female culture in ponds, while U.S. personnel will initiate controlled lab experiments evaluating growth energetics of male and female *Tilapia nilotica*.

In addition to the above mentioned projects, Kwei Lin is also presenting some of the basic CRSP work to the Second International Conference on Warm Water Aquaculture. In that presentation, he will evaluate limnological and management characteristics of acid-sulfate fish ponds in Thailand.

One reason for this capability to expand research in 1984 has been the move to Ayutthaya Hatchery as the CRSP site, while still maintaining the 12 ponds as Nong Sua for other work. The station manager there, Panu Tavarutmaneegul, has become particularly helpful in these new efforts.

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 few changes in staff composition since the initiation of the CRSP. Key additions to the group of CRSP participants include: Lic. Jonathan Espnoza O., who joined the CRSP as the Host Country Principal Investigator for the Honduras Project; Dr. Muhammad Eidman, who returned as the Host Country Principal Investigator for the Indonesia project; Lic. Nely Serrano and Mr. Azael Torres, who joined the CRSP as Host Country Research Associates for the Panama project in Gualaca and Aguadulce, respectively; and Dr. Panu Tavarutmaneegul, who has served a key role in the development of the CRSP project in Thailand.

In addition to staff with formal CRSP assignments, numerous individuals have participated in the development of the host country projects. In particular, the CRSP team in the Philippines reported that 17 professors, instructors and research assistants at the University of the Philippines in the Visayas played a major role in the accomplishment of the research program at the Iloilo site. CRSP research in Indonesia benefited from the participation of a number of undergraduate and graduate students carrying out pond dynamics experiments at the Bogor site. CRSP work in Thailand, which involved a move to a new research site during the reporting period, could not have been carried out without the aid of the technical staff at the Ayutthaya Hatchery near Bangkok.

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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 | |
| EXECUTIVE COUNCIL | | | | | | |
| Dr. Alfred M. Beeton | Chairman | • | • | | | Ann Arbor, MI |
| Dr. Wallis H. Clark, Jr. | Member | • | | • | | Davis, CA |
| Dr. E. W. Shell | 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 Manager | • | | • | • | Newport, OR |
| Ms. Michele Leslie | Assistant Program Manager | • | • | • | • | Newport, OR |
| Ms. Anne Kapuscinski | Graduate Research Assistant | | | • | • | Newport, OR |
| Mr. William R. Millison | Fiscal Officer | • | | | | Corvallis, OR |

¹Denotes 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 | | | • | | Comayagua, 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. 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 |
| Dr. Bette J. Premo | U.S. Research Associate | | • | • | • | Bogor, Indonesia |
| Mr. Komar Sumantadinata | H.C. Research Associate | | | • | | Bogor, Indonesia |
| Mr. Gerald Jacobs | Administrative Advisor | • | | | | East Lansing, MI |

¹Denotes primary work location and excludes host country site visits and travel for attendance of meetings.²Researchers 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. Orlando Garcia | H.C. Research Associate | | | • | | Divisa, Panama |
| Lic. Nely Serrano | H.C. Research Associate | | | • | | Gualaca, Panama |
| Mr. Azael Torres | H.C. 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. James Woessner | U.S. Research Associate | | • | • | | Diliman, Quezon City, The Philippines |

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

²Researchers 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 Honolulu, HI |
| Mr. William Coops | Administrative Advisor | • | | | | |
| 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. William R. Millison | Administrative Advisor | • | | | | 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 |

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 | |
| Dr. Vijai Sirsuwanatach | H.C. Research Associate | | | | | Bangkok, Thailand |
| Dr. William Chang | Technical Advisor | | | | | Ann Arbor, MI |
| Dr. Panu Tavarutmaneegul | Associate Researcher | | | | | Bangkok, Thailand |
| Mr. Nelson Navarre | Administrative Advisor | | | | | Ann Arbor, MI |

¹Denotes 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 projects and program management. The information used in compiling this unaudited financial statement is derived from audited quarterly reports provided to AID by the Management Entity Research Accounting Office and from annual reports provided by the Principal Investigators of the several projects. These data are intended to provide an overview of CRSP progress relative to budgeted amounts reflected in the CRSP Grant.

The AID funds expended relative to amounts budgeted for various program areas are presented in Table 3. The expenditures are based upon invoices paid by the Management Entity for cumulative costs incurred since receipt of the CRSP Grant. The expenditures should be regarded as minimum estimates since it is likely that additional expenses were incurred during the reporting period which had not been invoiced as of the date of this report.

The contributions of non-federal funds by the participating U.S. and host country institutions are presented in Table 4. The first column in this Table shows the amount of AID funds expended that require cost sharing. The amounts shown differ from the total AID funds expended (as reported in Table 3) because a variable proportion of AID funds were committed to purposes specifically exempted from cost sharing by the AID Grant Office. The data presented in Table 4 indicate that the participating U.S. institutions have shared in the cost of the CRSP in excess of grant requirements.

Unaudited host country contributions (in U.S. dollars) estimated by the Principal Investigators of the several projects are also presented in Table 4. Although host country cost sharing is not required, these data indicate a substantial commitment by the various host country institutions to participation in the CRSP, especially when the dollar amounts are related to local economies.

Table 3. SUMMARY OF AID FUNDS BUDGETED AND EXPENDED FOR CRSP PROJECTS AND MANAGEMENT

| | Budgeted | Expenditures |
|---|-------------|--------------|
| Collaborative Research Projects | | |
| Honduras - Auburn University | \$ 142,633 | \$ 136,014 |
| Indonesia - Michigan State University | 228,845 | 236,598 |
| Panama - Auburn University | 173,458 | 168,249 |
| Philippines - University of Hawaii | 225,003 | 176,439 |
| Rwanda - Oregon State University | 193,469 | 127,997 |
| Thailand - University of Michigan | 164,252 | 163,343 |
| Sub-Total | \$1,127,660 | \$1,008,640 |
| Program Management | | |
| Management Office | \$ 220,841 | \$ 144,823 |
| Executive Council and Technical Advisory Committee | 51,499 | 38,754 |
| Sub-Total | \$ 272,340 | \$ 183,577 |
| TOTAL | \$1,400,000 | \$1,192,217 |

Table 4. SUMMARY OF U.S. INSTITUTION AND HOST COUNTRY CONTRIBUTIONS TO COLLABORATIVE RESEARCH PROJECTS

| Project | (a) AID Contribution ¹ Subject to Cost Sharing | (b) U.S. Institution Contribution | (c) Program Total (a+b) | (d) U.S. Inst. Cost Sharing (%) (b ÷ c x 100) | (e) Host Country Contribution ³ |
|----------------------------------|---|---|-------------------------------|--|--|
| Honduras - Auburn Univ. | \$ 86,687 | \$ 37,394 | \$ 124,081 | 30 | \$ 88,000 |
| Indonesia - Michigan State Univ. | 180,573 | 51,610 | 232,183 | 22 | 58,740 |
| Panama - Auburn Univ. | 102,120 | 46,688 | 148,808 | 31 | 149,000 |
| Philippines - Univ. of Hawaii | 192,246 | 64,082 | 256,328 | 25 | 53,500 |
| Rwanda - Oregon State Univ. | 127,997 | 46,113 | 174,110 | 26 | 170,000 |
| Thailand - Univ. of Michigan | 84,909 | 28,303 | 113,212 | 25 | 86,550 |
| TOTALS | \$774,532 | \$274,190 | \$1,048,722 | 26 ² | \$605,790 |

¹Estimated percentage of AID funds expended that require cost sharing (explanation in text).

²This figure must equal or exceed 25%.

³Estimates provided by project Principal Investigators.