

# I CRSP Research Program Background

The current period was characterized by the following accomplishments: Initiation of a new one-year transition year Work Plan (the Interim Work Plan, 1995-96); completion of research activities scheduled under the Seventh and Interim Work Plans; successful completion of the Egypt project and publication of research results in the Egypt Project Final Report; revision of the Africa Work Plan and resumption of research activities which were originally planned for Rwanda in Honduras and in the U.S.; and development of site selection criteria for a new African site. The resiliency of the CRSP has enabled it to rebound from the challenges caused by the shadow of the terrible events which engulfed Rwanda.

Management challenges resulted from delays in receiving authorization from USAID for a 5-year program continuation. An interim Work Plan was approved by the Technical Committee in June 95 to cover the one year extension granted by USAID.

The following report summarizes research activities conducted during this transition year. The scientists' descriptions of their research activities have not been edited by the Management Office except for minor typographical errors.

In all previous years the Management Office devoted extensive efforts to the Annual Technical Reports. Due to an enhanced work load placed on the Management Office from the Continuation proposal and one-year extension, staff were unable to perform this function this year. The companion volume to this Annual Technical Report is the Annual Administrative Report which enumerates achievements in administration, research, and outreach activities, and

as well summarizes program history, personnel, financial status, and publications. It also contains the abstracts of all technical reports included in this volume (See Appendix B for the table of contents to the Administrative Report).

## The CRSP Global Experiment and Related Activities

Since its inception, the goal of the CRSP has been to improve the efficiency of pond production systems through sustainable aquaculture. The strategy adopted by the CRSP in pursuit of this goal has been to undertake the basic research required to understand and improve the efficiency of pond culture systems.

In 1978, a technical plan proposing this strategy was developed under a planning study funded by USAID. The technical plan reviewed and synthesized literature on state-of-the-art pond aquaculture. Overseas sites were surveyed to determine research needs and availability of local support in host countries. The findings from these surveys were then incorporated into planning guidelines.

The literature overview that was conducted during the planning phase showed that different pond systems exhibited considerable variation in productivity. Pond aquaculture had been practiced for centuries as a highly developed art form, and the literature was replete with reports about practices

that had produced high yields. However, the results were often not reproducible when the same practices were applied to other ponds. It was clear that there were subtle differences regulating productivity from pond to pond and from site to site, but the nature of these differences remained obscure.

The Global Experiment was intended as a comparative study of aquaculture pond dynamics—one that would help us begin to understand how and why ponds at different geographic locations function differently, and how the management of those ponds might be adapted to different sets of environmental conditions to optimize production. Hence, a common set of experiments was implemented globally, following a standardized experimental protocol at a number of research sites around the world.

The initial technical design for the Global Experiment involved monitoring environmental and fish production variables at seven geographical locations in six countries (Figure 1). Observations specified in biennial (originally annual) Work Plans are made on twelve or more ponds of similar size at each location. The variables observed, frequency of observation, and materials and methods used are uniform for all locations. Two brackish water and five freshwater research sites were selected in Central America (Panama and Honduras), Africa (Rwanda), and Southeast Asia (Indonesia, Thailand, and the Philippines) in 1982. All of the sites were within a zone of 15 degrees north and south of the equator and represented the three major tropical regions where advances in pond aquaculture would be most beneficial and most apt to succeed. Subsequent changes in 1987, mainly in response to funding constraints, required that research be continued at only three (Thailand, Rwanda, Honduras) of the six countries originally selected to maintain sites in the three major regions of the tropics. In 1991, the CRSP program was expanded by the initiation of a sub-project in the Philippines (at a new site in Central Luzon) and the beginning of a completely new project in Egypt. Termination of research activities in Panama and funding constraints in 1987 caused a hiatus in brackish water research which was resumed in 1993 with the addition of a new coastal site in Honduras. The outbreak of civil war in Rwanda in April 1994 caused the cessation of all CRSP research activities in Rwanda. The Egypt project, under a separate grant from the Cairo Mission, was originally slated to end in 1994; however, after a positive review, it was extended for half a year and ended in March 1995.

The first cycle of experiments aimed to develop a set of baseline data on ponds at the various sites. Subsequent Global Experiment studies have focused on investigations of the effects of different fertilizer regimes on pond productivity and yield. The Global Experiment has been further strengthened by the addition of the Egypt project (the only arid CRSP site) because researchers can now compare pond processes observed in humid and arid environments. Although all CRSP research activities have ceased in Egypt, the CRSP hopes that collaboration may be resumed in the future. This may happen under the aegis of the International Center for Living Aquatic Resources Management (ICLARM) which is currently considering Egypt as a site for its aquaculture research activities.

As CRSP research progressed through the 1980s, new questions surfaced—questions that differed from site to site and needed to be addressed with specific experiments. This family of experiments, though separate from the standardized Global Experiment, yet performed concurrently with it, is also global in nature. For example, currently all CRSP sites conduct studies on sediment dynamics and their influence on water quality in tilapia or polyculture ponds. Pond soils have been analyzed in an attempt to establish baseline information and to investigate the role of sediments as nutrient sinks. This research dove-tails with the CRSP's interest in the environmental effects of aquaculture on the aquatic environment. The CRSP is currently conducting pioneering research on the influence of pond management practices on effluent load. The aim of this research is to maintain high productivity while preventing nutrient wastage and concurrent pollution. The findings gained from these studies will have worldwide practical application.

After the first few years of Global Experiment research, economic analyses of pond aquaculture systems were added as a component of the aquaculture development strategy in both the U.S. and host countries. Previous research had relied on numerous and often tenuous assumptions that reflected how much remained unknown about the dynamic mechanisms regulating pond productivity and confirmed the inadequacy of the existing database. To find out if contemporary pond management practices were in fact the most efficient, CRSP researchers developed quantitative production functions. An extensive comparison of the socioeconomic dimensions of CRSP production techniques among sites is helping CRSP researchers to understand the similarities and differences of socioeconomic influences on their work.

## Data Analysis and Synthesis

CRSP planners recognized at the outset that aquaculture ponds are extremely complex ecosystems. This complexity has been reflected in the number of variables and frequency of observations required by the experimental protocols specified in the CRSP Work Plans. Although researchers at each of the overseas field sites are free to analyze their own data and publish their findings, it was recognized that the management and analysis of the global data set (i.e., the data generated by all the field sites) would require the establishment of a central data storage and retrieval system. This Central Data Base was originally established at Oregon State University and maintained by the Management Entity until Spring of 1993 when it was transferred to the University of Hawaii at Hilo.

Standardized data are tabulated at each research location in accordance with CRSP Work Plans. At the individual sites, data on physical variables (e.g., solar radiation, temperature, and rainfall) and chemical variables (e.g., water and soil characteristics) are collected concurrently with biological measurements (e.g., primary productivity, fish growth, and fish production). Over 160 physical, chemical, and biological variables (approximately 90,000 observations per site and year) are observed. Whereas the resulting sets of data are useful for site-specific studies, the compilation of all the individual data sets into the Central Data Base provides opportunities for many kinds of global analyses. Detailed standardized records such as those found in the CRSP Central Data Base are rare in the aquaculture literature. An internal review commissioned by the Program Management Office confirmed that all data from research activities conducted under the First through the Fourth Work Plans are already in the data base, and entry of data from the Fifth Work Plan is almost completed. The Central Data Base has continued to expand through the inclusion of new data generated under the Sixth and Seventh Work Plans. Other important features of the database are robustness and flexibility which ensure the inclusion of data generated on new sites.

CRSP participants also decided that the comprehensive analysis and interpretation of global data would be greatly enhanced through the formation of an independent team of researchers who could

devote their efforts to this type of analysis. This task force was formally established in 1986 as the Data Analysis and Synthesis Team (DAST). The charge of the DAST is to systematically analyze pond processes and to develop computer models that reflect our growing understanding of pond systems. The DAST members are more than end-users of the data base; rather, they participate actively in the design process of the next cycle of Global Experiments. Communication between the DAST and field researchers assures that the experimental design encompasses the information needs of the DAST. The benefits of analyzing global data and synthesizing information into computer models that simulate pond conditions occur on several levels: production management, design, and planning. The quantification of relationships between variables and the effects of different treatments allows farmers to adapt general management techniques to the specific local constraints of climate, water, feed, and fertilizer availability in order to optimize production. The design of production systems will be improved by matching production facilities and costs with production goals.

## Special Topics Research

The Special Topics component of the CRSP was created to provide opportunities for host country and U.S. researchers to collaborate on original research directed toward the needs and priorities of each host country. The intent is to strengthen linkages and contribute to the development of research capabilities within host country institutions by providing opportunities for scholarly involvement of faculty and advanced students. This component also provides host country institutions and agencies with access to the human resources of the CRSP in seeking solutions to short-term local problems. Projects focus on specific aspects of the Global Experiment that would benefit from site-specific, detailed investigations.

Proposals for these Special Topics Research Projects are developed collaboratively by the host country and U.S. scientists. The proposals are endorsed by the host country institution and are reviewed by the CRSP Technical Committee and other CRSP advisory groups for technical merit and relevance to the general goals of the CRSP. The projects must also be consistent with USAID and host country development strategies and priorities.

PD/A CRSP Research Locations around the World

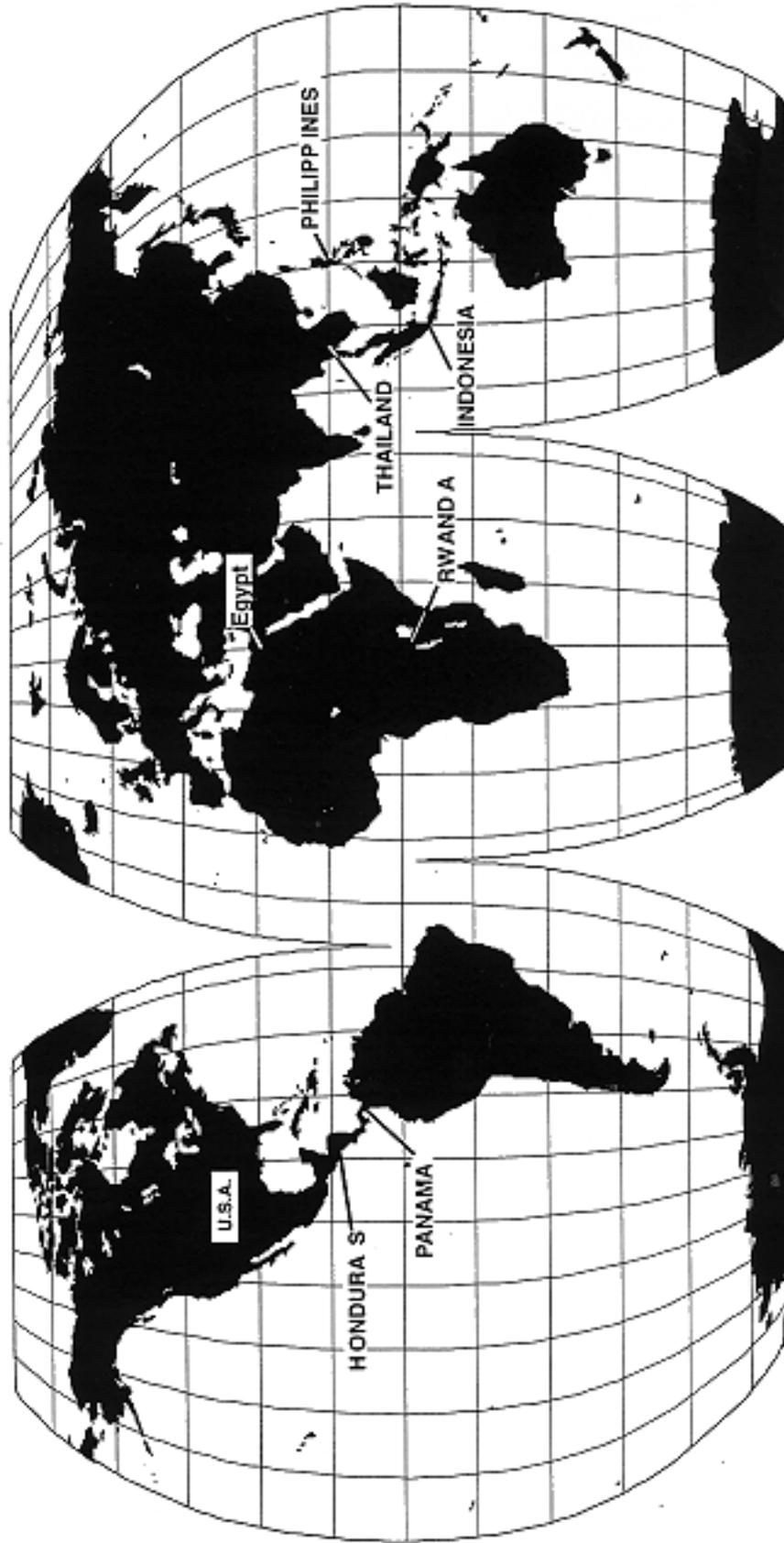


Figure 1. Past and present PD/A CRSP research locations in Central America (Honduras, Panama), Africa (Egypt, Rwanda), Southeast Asia (Indonesia, the Philippines, and Thailand), and the USA.

Although Special Topics Research Projects are an important part of the CRSP, they are not a major component in terms of funding support or time expenditure. Twenty to twenty-five percent of each researcher's time typically is devoted to this activity. The CRSP places high priority on long-term basic research. Host country institutions and USAID Missions, however, often consider basic research activities such as the Global Experiment to be of low priority. Consequently, administrators in the host countries sometimes have difficulty justifying participation in the CRSP. The CRSP support for the Special Topics Research activities helps them to see the value of their institutions' participation in the CRSP.

## CRSP Work Plans

From the CRSP's beginning, the Technical Committee of the PD/A CRSP has had the responsibility for developing technical plans to guide the research efforts of each experimental cycle. During the first three cycles of the program, when global experiments were the main emphasis, CRSP Work Plans were developed annually. The First Work Plan specified a standard protocol for the preparation and stocking of ponds at all locations. Research in the Second Work Plan compared the responses of ponds receiving organic fertilizers with the responses of ponds that received inorganic fertilizers. Experiments described in the Third Work Plan investigated the effects of varying levels of organic fertilizers on pond dynamics.

In response to recommendations of the External Evaluation Panel during the first Triennial Review, a biennial approach to Work Plan development and execution was adopted beginning with the Fourth Work Plan. Two-year operating cycles allow more time for completion and evaluation of experiments before plans for the next cycle must be completed.

Although the research program has evolved so that the Global Experiment and site-specific experiments are conducted at the various sites, the concept of a standard protocol for research at all sites has been maintained. The standard protocol was initially introduced as a part of the First Work Plan and has been improved with each subsequent Work Plan. In

1992 it finally evolved into the PD/A CRSP's *Handbook of Analytical Methods*, compiled by the Materials and Method Subcommittee of the Technical Committee and distributed to CRSP participants.

The Fourth Work Plan included tests of specific hypotheses formulated after review of the first three cycles of CRSP research. Special attention was paid to the economic aspects of CRSP pond management procedures. Further, the Data Analysis and Synthesis Team (DAST) started to systematically use the Central Data Base.

The Fifth Work Plan was developed by the Technical Committee in May 1989, and encompassed research efforts carried out between 1 September 1989 and 31 August 1991. In addition to the Global Experiment, each site proposed various studies that addressed specific aquaculture needs of the host countries. Field experiments with farmer-cooperators were initiated, allowing researchers to evaluate their strategies under 'real life' conditions, and strengthening the linkage between research and practice. Economic analysis became another tool by which the CRSP measured the quality of its research achievements. The DAST's efforts focused on refining models and developing fertilizer guidelines.

The Sixth Work Plan, which began on 1 September 1991 and ended 31 August 1993, was approved at the Ninth CRSP Annual Meeting in May of 1991. A 20% funding increase allowed the CRSP to broaden its research scope. Nine supplemental projects were included in the Sixth Work Plan. One of these studies was a preliminary investigation of women's participation in fish culture activities in Rwanda. This study was used to attract a buy-in from USAID's Women In Development program (WID) to perform more complete investigations on the role of gender in fish culture in Rwanda. Also, under the auspices of the Thailand team, research activities were re-initiated in the Philippines.

The Seventh Work Plan is characterized by several changes. The CRSP resumed its original investigation of pond dynamics in brackish water systems, a line of research that had been temporarily suspended when the CRSP's brackish water sites in Panama and the Philippines were lost in 1987. This Work Plan also introduced a new research focus, biotechnology, which has the potential to greatly aid the aquaculture industries in the U.S. and host

countries. Experiments originally scheduled to be conducted in Rwanda had to be reassigned to different sites after the outbreak of civil war. It is a sign of the CRSP's resiliency and the global nature of the program that the Africa team was able to regroup and develop a revised Seventh Work Plan whose experiments are currently conducted in Honduras and the United States. Furthermore, research on the influence of elevation on tilapia production originally conducted in Rwanda is now being continued in the Philippines.

The Interim Work Plan covers experiments to be conducted during the transition year (May 1995 through April 1996). This deviation from the usual

biennial Work Plan format was necessitated by delays imposed by USAID in the grant renewal process. In addition to a description of experiments, this Work Plan also outlines activities of the Africa Site Selection Team.

This report covers the second year of the Seventh Work Plan for all sites but Egypt. The Egypt project activities were reported separately in the Egypt Project Final Report, which is available as an addendum to this report (Appendix C) beginning on page 177). Studies from Sixth Work Plan and activities initiated under the Interim Work Plan are also included in this report.