Aquaculture Technology Development Program

Auburn University - U.S.A.I.D.
Cooperative Agreement

No. DAN-4180-A-00-8008-00

Annual Report 1992
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7. Annual Research Summary, 1992, Department of Fisheries and Allied Aquacultures, Auburn University

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EXECUTIVE SUMMARY

This is a report of Cooperative Agreement No. DAN-4180-A-00-8008-00 activities for calendar year 1992, the final year of a five-year program implemented during calendar years 1988 through 1992. This program was preceded by a similar Cooperative Agreement for calendar years 1982-87. The purpose of the current Cooperative Agreement is aquacultural technology development. Key activities include research on tilapia monosex seed production, polyculture, and economic aspects of aquaculture; provision of specialized information to users; international networking; and training and education.

Research was conducted on methods to improve the efficiency of monosex seed production of tilapia. Specific topics investigated were progeny testing of tilapia which had undergone hormonally induced feminization (one phase in the potential development of brood fish that produce all-male offspring) and masculinization of larval tilapia with a steroid-like growth promoter, trenbolone acetate. Research on polyculture technology focused on the impact of size at stocking on growth of the giant Australian freshwater crayfish when polycultured with tilapia.

Analysis of economic performance of aquacultural development projects in developing countries continued in 1992. A comprehensive document on aquacultural economics in Thailand, Panama, Jamaica, Guatemala, Philippines and Rwanda was finalized and revised for oral presentation at AID/W. A description of family-scale fish farming in Guatemala, including detailed financial and economic analyses, was published in 1992. Auburn University also implemented a Basic Ordering Agreement with USAID/Philippines to conduct a 4-month, 9-person multi-disciplinary assessment of the shrimp industry in that country; the consultant team consisted of local and US specialists, including an aquacultural economist, a shrimp processing specialist, and an aquatic environmental specialist from Auburn University.

Information of a general and technical nature about fisheries and aquacultural development was made available through publication of a newsletter, 11 technical guides for developers and producers (English, Spanish, and French) and a fact sheet for decision makers in development agencies. A network database of aquacultural specialists worldwide was completed and incorporated into a broader university database. A database was developed which contains the citations of all publications by faculty and staff and thesis and dissertation citations and abstracts of all graduates of the department of Fisheries and Allied Aquacultures.

In 1992, 46 international students from 23 countries were enrolled in M.S., M.Aq. and Ph.D. studies in fisheries and aquaculture. Cooperative Agreement funds gave substantial support to the direction, supervision and assistance from faculty for those international students for whom English is a second language. In addition, 18 internationals participated in non-degree training and research in various aspects of aquaculture and fisheries, for which certificates were awarded. Among these were ten senior visiting scientists.

In 1992, ICAAE provided 634 person-days of short-term work assignments in 14 countries. In addition, a large number of international service activities was conducted on-campus and within the U.S. Partial support for these activities was provided by the Cooperative Agreement.

Work plans for 1992 anticipated expenditures of $282,646, including incremental funding of $255,000 plus $27,646 estimated carryover from 1991. Actual expenditures in 1992 were $265,031 or approximately 94% of anticipated levels. Funds carried over have been programmed primarily for salary support in 1993 of ICAAE Associates previously supported through AID funds and for whom alternative support has not yet been identified.
BACKGROUND

The first Cooperative Agreement between Auburn University and AID began January 1, 1982, and terminated December 31, 1987. In 1985, the International Center for Aquaculture undertook a formal planning process, which included the identification of critical problem areas for aquacultural development and formulation of work plans to address these problems. Thereafter each annual work plan of the Cooperative Agreement has been comprised of several activities each of which addresses one of the pre-determined "critical problems." The first annual work plan was initiated on January 1, 1986. Goals, objectives, project activities, and work plans as originally conceived are reported in "Cooperative Agreement Work Plans: 1987-92," a document submitted to AID in 1986. Some modifications of the initial projects have occurred over time as would be expected of a dynamic process in which assumptions and conditions change.

This is the annual report for 1992, the fifth year of the present Cooperative Agreement which began January 1, 1988. Five fundamental problems were identified: I) inadequate research data are available on aquacultural production systems appropriate for developing countries; II) information on development in aquaculture and technical information of a practical nature is not generally appropriate or available in LDC's and is thus a constraint for technology transfer; III) there is a lack of personnel in LDC's with specialized skills, knowledge and advanced training in aquacultural subjects; IV) systematic, complete and current information on aquacultural specialists working worldwide is generally inaccessible; and V) the Cooperative Agreement must be effectively administered. The following objectives were selected to address the problems in 1992:

1. Improve the efficiency of monosex seed production of tilapia
2. Develop polyculture technology
3. Assess economic performance of aquacultural development projects in LDCs
4. Publish ICA COMMUNICAЕ
5. Publish technical guides for producers
6. Publish and distribute AQUACULTURE NEWS
7. Initiate a program of information exchange in Africa
8. Supervise foreign student study programs
9. Conduct non-degree aquacultural training for international participants
10. Model, develop program and manual to make the IAN database more user friendly
11. Plan, manage and report Cooperative Agreement activities
PROGRESS ACHIEVED IN 1992 WORK PLANS

PROBLEM I Inadequate research data are available for aquacultural production systems appropriate for developing countries

Background: Differing climatic, economic, and social conditions in LDC's require modified or completely new production systems from those utilized in the developed countries. Most of the needed research can and should be conducted in the target countries. Selected phases of investigation can most effectively be carried out where better support, facilities, and backstopping are available. On-campus research selected for support through the Cooperative Agreement is oriented toward development of aquacultural technology for income generation by small- and medium-scale producers, and for increased nutritional benefits from aquaculture.

Aquaculture is a relatively new agricultural production alternative for most developing countries, for which information on economic viability is limited. Insufficient documentation of baseline economic information and economic performance has hindered planning of aquacultural development projects and their evaluation.

Strategy for addressing problem: Most ICAAE/FAA matching funds were expended to support Cooperative Agreement related research in the fields of fish diseases and pathology, genetics and breeding, hatchery management, nutrition, and water quality.

Climatic conditions in tropical countries permit a more accelerated research program than would be possible in Alabama where winter generally interrupts production research. This is especially true for investigation on hatchery management, genetics, integrated farming systems, and other country-specific production systems. Memoranda of Understanding have been signed between Auburn University and several universities in developing countries with which there have been previous associations. Collaborative R&D activities between Auburn University and the Asian Institute of Technology (AIT) in Thailand have been funded through USAID. University Development Linkage proposals between Auburn University and institutions of higher education in Thailand were developed for evaluation by AID.

On-campus activities were carried out in 1992 at Auburn University to address the research objectives specified below.

Problem I. Objective 1: Improve Monosex Seed Production for Tilapia

Two studies related to the production of monosex tilapia were undertaken in 1992:

1. Development of "YY" male tilapia.
2. Evaluation of trenbolone acetate to sex reverse tilapia.

Development of "YY" male tilapia.

Inheritance of sex in *O. niloticus* is often described as a simple xx-xy Mendelian trait where the sex ratio in the next generation will be 50:50. In such a system, a phenotypic female with a male genotype, mated to a normal male, will give 25% female and 75% male progeny with a third of the males having a yy "supermale" genotype. Males with a yy genotype crossed with a normal female should produce 100% xy normal male progeny.
In 1992, *Oreochromis niloticus* fry were treated with diethylstilbestrol, producing a phenotypic female population which contained both male (xy) and female (xx) genotypes. Individuals from this phenotypically female population were paired with normal males. Nontreated females were also paired with normal males. The sex ratio of offspring from each pair in the two groups were examined. The mean sex ratio of normal male x female pairs was not significantly different from 50:50, but the ratio for some pairs did differ significantly from 50:50. Hormone-treated females produced a sex ratio that suggested the presence of "YY" males among the offspring; the mean expected % males from the hormone-treated female population was 59.4% while the observed was 60.2%. In 1993, males from male-skewed populations will be mated with normal females in an attempt to confirm which fish are "YY" males.

**Evaluation of trenbolone acetate to sex reverse tilapia.**

Trenbolone acetate is a steroid-like growth promoter in cattle which has androgenic properties that may be adequate for sex reversal of tilapia. It was incorporated into the feed of *O. niloticus* at rates of 0, 20, 40, or 80 mg/kg of feed. Fry were fed one of the above rations for 28 days in aquaria. At harvest, mean length, weight, and survival were determined. Fish were restocked into 20-m² tanks, given a non-treated feed, and grown to 5 cm. All fish were preserved for later examination. After 28 days of treatment, the average lengths ranged from 18.1 to 19.4 mm and weights from 0.13 to 0.16 g with no anabolic effect of treatment evident. Survival ranged from 44 to 56 %. Sex ratios of preserved fish have not yet been evaluated.

**Problem I. Objective 2: Develop Polyculture Technology**

**Fish-prawn polyculture**

Previous research had been on polyculture of the freshwater prawn, *Macrobrachium*, and tilapia. More recently research suggested the giant Australian crayfish may be superior to *Macrobrachium* for polyculture with tilapia. The Australian crayfish has been shown to have better cold tolerance and faster growth than *Macrobrachium*. Other promising characteristics include large sizes (>400 g), simple life cycles where eggs hatch directly into juvenile crayfish (no larval stages requiring specialized feeding and rearing) and high market value. Of the three species evaluated, red claw *Cherax quadricarinatus* shows the greatest potential as a culture species both in the Southeastern United States and in many developing countries. Due to these factors it should have greater potential for aquaculture in the wide range of conditions prevailing in developing countries.

In 1992 the impact of initial stocking size on final size during growout was studied. Red claw were stocked at sizes of 0.1, 2.0, and 10.0 grams each. Survival rates were directly related to initial size: 15%, 27%, and 55% from smallest to largest initial size. Red claw reached a size of 36 to 48 grams. Results suggest a minimum initial size of 1 to 2 grams for stocking in rearing ponds. Research will continue in 1993.

**Problem I. Objective 3: Assess economic performance of aquacultural development projects in LDC's**

Aquaculture is an innovative production alternative for which published information on its economic viability is limited. Insufficient documentation of baseline economic information has hindered planning of aquacultural development projects and their evaluation. Economic results of previous projects provide insight for development of a framework for economic assessment, and clarify the type of information to be collected and considered for project planning. The objectives
of this continuing effort are to: 1) assess information on economic viability of tropical aquaculture in LDC's, and 2) provide a framework for future assessment of economic performance of aquaculture. It is hoped that this activity will foster expansion of aquaculture by demonstrating economic viability.

**Economic analysis of aquaculture.** In 1991, an analysis entitled "Economic viability of farm diversification through tropical freshwater aquaculture in less developed countries" was finalized. Data had been collected from several countries considered representative of larger world regions and production methods. Selected countries included: the Philippines with aquacultural production levels ranging from subsistence systems to commercial pond, cage, and pen; Jamaica where commercial culture of tilapia has grown from near zero to 6 million pounds annually in less than 15 years; Panama with community-oriented integrated livestock-fish production systems; Guatemala with family-scale tilapia production systems for sale and consumption by producer families; Rwanda with high altitude ponds used for low input family-scale fish culture; and Thailand where researchers experimented with integration of livestock, fish and vegetables. Publication through the Research and Development Series at Auburn University has already been accomplished for Panama, Jamaica, and Rwanda. The history and lessons learned about aquacultural development in Guatemala, "Family-scale fish farming in Guatemala: an example of sustainable aquacultural development through national and international collaboration" was published in 1992 with partial support from the AID Program Support Grant as Research and Development Series No. 37, Alabama Agricultural Experiment Station, Auburn University, August, 1992 (Attachment 1). The global economic analyses will be presented to a multi-agency audience in Washington in March, 1993.

An economic analysis of several aquacultural practices tested by the Auburn University CRSP researchers in Honduras was undertaken as a Cooperative Agreement task. Findings were presented at the Pond Dynamics CRSP annual meeting in 1992.

In 1992 Auburn University implemented a Basic Ordering Agreement with USAID/Philippines to conduct a 4-month, 9-person multi-disciplinary assessment of the shrimp industry in the Philippines. The consultant team consisted of local and US specialists, including an aquacultural economist, a shrimp processing specialist, and an aquatic environmental specialist from Auburn University. Major emphasis was on economic assessment, but production technology, marketing, environmental impact, and supporting infrastructure were also analyzed. The draft final report was submitted in December 1992, and the final version was submitted in January 1993.

**PROBLEM II:** Information on developments in aquaculture and technical information of a practical nature is not generally appropriate to, or available in LDC's, and is thus a constraint for technology transfer.

**Background:** The transfer of aquacultural technology to LDC's can be achieved through long- and short-term technical assistance and by the distribution of appropriate written information. Information on advances and applications of aquacultural technology and related development issues is not adequately available to technicians and development planners working internationally. The few aquacultural specialists native to, and working in developing countries often do not have opportunity to fully use their knowledge and skills to effect aquacultural development in their countries. It is difficult for them to obtain information on developments in the discipline, and to communicate their experiences to others. Requests to Auburn University from LDC's for information on all aspects of aquaculture increase yearly. These requests come from former students, USAID missions, other international development agencies, private and voluntary
organizations, LDC agencies and institutions, and many individuals who learn of Auburn expertise in aquaculture and fisheries.

**Strategy for addressing problem:** The majority of ICAAE/FAA staff, particularly those involved in relevant research, frequently provide technical information by telephone or mail to individuals and agencies involved in aquacultural development in LDCs. Approximately eight percent of ICAAE/FAA matching resources finance this activity.

Three objectives related to the transfer of aquacultural technology were addressed in 1992:

**Problem II. Objective 1:** Publish *ICA AE COMMUNICA E*

This publication summarizes accomplishments and activities of the aquaculture and fisheries program at Auburn University. It is distributed free of charge by the International Center for Aquaculture and Aquatic Environments to interested persons and relevant organizations. Current subscribers number more than 2,200 of which approximately half are outside the United States. The *ICA Communicae*, Volume 14, No. 1-2 presented issues and summarized research relevant to tropical areas. Composition of materials included short review articles on technical, social and economic subjects, abstracts of theses and dissertations, lists of recent publications, notes on special research projects, and identification of prominent international students and visiting scientists. (See Attachment 2)

**Problem II. Objective 2:** Publish technical guides for producers

Production of a 20-title series of outreach publications, *Water Harvesting and Aquaculture for Rural Development*, was a continuing activity of the International Center for Aquaculture. The intended audience is students, technicians, extensionists, development specialists, and producers with limited background in aquaculture. Demand for these guides has been high. By the end of 1991, all titles were available in English, 10 in Spanish, and 19 in French. In 1992 the remaining 10 titles in Spanish and one in French were completed (Attachment 3):

**English translation of Spanish titles**

- Chemical fertilizers for fish ponds
- Transporting fish
- Feeding your fish
- Eliminating unwanted fish and harmful insects
- Introduction to fish culture in ponds
- Fish culture in rice paddies
- Introduction to cage culture
- Production of 1-gram mixed-sex *O. niloticus* fingerlings
- Single pond system for sustainable production of *O. niloticus*
- *O. niloticus* production in tanks

**English translation of French title**

- *O. niloticus* production in tanks
Problem II. Objective 3: Publish *Aquaculture News*

*Aquaculture News* is a one-page fact sheet. Its purpose is to provide decision-makers in development organizations up-to-date information on developments in aquaculture in a concise form. It is expected that interest in aquaculture as an alternative development intervention will be stimulated. In 1992, one issue of this publication (Attachment 3) was distributed to more than 200 agencies, including AID Missions, World Bank Offices, FAO, interested LDC government agencies, private foundations, and PVO's. Efforts that normally would have been directed toward the publication of additional issues of the *Aquaculture News* were directed toward the publication of a brochure outlining the development goals of our International Center for Aquaculture and Aquatic Environments (Attachment 4).

Problem II. Objective 4: Africa initiative for information exchange.

ICAAE undertook an aquatic sector assessment in 1992 which was designed to identify opportunities for enhanced aquacultural activity in the Africa Region. The survey had three principal objectives:

- Describe the present aquacultural situation in participating countries
- Identify constraints to further aquacultural development
- Inventory the technical literature available in participating countries

Fifty-one questionnaires were sent to government agencies, research institutions, and universities in 22 anglophone and francophone countries: Botswana, Ethiopia, Ghana, Kenya, Lesotho, Malawi, Namibia, Nigeria, Swaziland, Tanzania, Uganda, Zambia, Zimbabwe, Burkina Faso, Burundi, Congo, Côte d'Ivoire, Cameroun, Guinea, Madagascar, Morocco, and Togo. Additionally, regional fisheries or aquacultural programs were contacted: ALCOM in the SADAAC Region, IFIP based in Burundi, JEFAD located in Ethiopia, and the PTA Fisheries Unit headquartered in Zambia. Fourteen of the groups contacted responded. Eleven respondents, from nine countries, provided all information requested (Attachment 5).

PROBLEM III: There is a lack of personnel in LDC's with specialized skills, knowledge and advanced training in aquacultural subjects.

**Background:** The lack of educated personnel is a recognized constraint to development of aquaculture in LDC's. Institutional capacity and experience for educating aquaculturalists is very limited in LDC's compared with most other fields of agriculture. Aquaculture has been practiced for over a thousand years, but on a traditional and empirical basis. Prior to the early 1950's there was little organized research and teaching in aquaculture in any country. Today skills and information are rapidly improving in developed countries, but much less so in developing countries. Developing countries usually have inadequate resources to train aquacultural specialists and develop their own information base. Qualified teachers are few, and equipment and facilities to provide students training in theory and practice are generally lacking or inadequate.

**Strategy for addressing problem:** ICAAE/FAA matching funds was used to support the teaching of university level courses in the principles and practices of aquaculture. Approximately one-third of the participating students were non-U.S. citizens. Activities were undertaken in 1992 that addressed the following two objectives:
Problem III. Objective 1: Supervise foreign student study programs

Considerable time is spent on foreign student affairs. This includes orientation, academic advising, interpreting transcripts from foreign universities, advising on visa affairs, communicating to sponsors on student progress and other sponsorship problems, assisting students with settling-in and other personal needs, such as frequent trips to airports for arrivals and departures, assisting in locating housing, counseling, special assistance in manuscript preparation, etc. Numerous inquiries from overseas were responded to and proposals were developed in response to several special training requests. Training-related activities include assisting, placing and supervising visiting international scientists and hosting other international program visitors. Dr. John Grover had responsibility for these tasks, helped as needed by other faculty.

In 1992, 46 foreign students were enrolled in the Department of Fisheries and Allied Aquacultures. They are citizens of 23 countries:

- Indonesia
- Egypt
- Malaysia
- Bhutan
- Surinam
- India
- Mexico
- Nigeria
- France
- Korea
- Ivory Coast
- United Kingdom
- Japan
- Thailand
- Rwanda
- Brazil
- Turkey
- Republic of China
- Costa Rica
- Pakistan
- Trinidad
- Peoples Republic of China
- France
- Korea
- Ivory Coast
- United Kingdom
- Japan
- Thailand
- Rwanda
- Brazil
- Turkey
- Republic of China
- Costa Rica
- Pakistan
- Trinidad
- Peoples Republic of China

Fifteen of those foreign students, representing countries in Africa, Asia, and Latin America, graduated in 1992: 1 BS, 10 MS or MAq, and 4 PhD.

In order to improve appropriateness of thesis research to problems in their home countries, international students often undertake research problems that are of limited interest to the Alabama Agricultural Experiment Station. This includes working with aquatic organisms such as tilapia and freshwater crustaceans that are important in the tropics as food and cash crops; but have less potential for culture in the continental U.S. Additional justification for Cooperative Agreement support to this activity is that the effort required to direct international graduate student research, thesis preparation and publication is about twice that required for American students. Ten FAA faculty supervised international student research but their time was not charged to the Cooperative Agreement.

Problem III. Objective 2: Conduct non-degree aquacultural training for international participants

Aquacultural Training Program (ATP) is a non-degree training program conducted specifically for foreign participants (Attachment 6). The ATP has been conducted annually from March to July since 1976. Through 1992, 227 participants had received certificates for successfully completing the four-month program. In 1992, the course was attended by seven participants from six countries:

- Bangladesh (1)
- Congo (1)
- Rwanda (1)
- Taiwan (2)
- Argentina (1)
- USA (1)

Dr. William Deutsch was the ATP coordinator and was assisted by a full-time assistant, Graduate Student Jonathan King. Subjects taught were principles of aquaculture, water quality, fish reproduction, hatchery management, pond engineering, fish production systems, economics of aquaculture, fish nutrition, fish diseases, fish morphology, extension methods and research
methods. These subjects were taught by 30 to 40 faculty and staff of the departments of Fisheries and Allied Aquacultures, Agricultural Economics and Rural Sociology, and Agricultural Engineering. The participants' time was equally divided between classroom and field activities. Each student was assigned a pond and produced a crop of fish. Four field trips were undertaken to visit aquacultural related facilities in the region. The ATP had previously received considerable support through the Cooperative Agreement, but this program has been generally self-supporting in recent years.

The ICAAE undertook two additional non-degree training activities in 1992:

- João Lorena Campos from Brazil came on a 6-month internship to study catfish and sportfish management in southeast US.
- Benoit Ingeessan from the Ivory Coast received a 5-week Cochran Fellowship from USDA/OICD for aquacultural training

Visiting scientists: The ICAAE is often requested to design and conduct special purpose training courses. Dr. Grover has responsibility for coordinating this program in which there is significant participation of other faculty and staff. No support to the visiting scientists was provided through the Cooperative Agreement grant.

In 1992, 22 person-months of specialized training were provided through the department of Fisheries and Allied Aquacultures to five visiting scientists:

Dr. Roshada Hashim  
Dr. Hussein A.E. Ka-oud  
Dr. H. Prem Kumar  
Dr. Kasturi Samantaray  
Dr. Alaa A. El-Dahhar

Malaysia  Fish nutrition
Egypt  Fish health
India  Fish nutrition
India  Fish nutrition
Egypt  Fish nutrition

Also, five Post-doctoral Fellows were assigned to the Department of Fisheries and Allied Aquacultures in 1992:

Prof. Heyi Tong  
Dr. Nickoli Fijan  
Dr. Dehai Xu  
Dr. Somsak Vininthantrat  
Dr. Annick Ramboux

P.R. China  Aquaculture
Yugoslavia  Fish health
P.R. China  Fish health
Thailand  Fish health
Belgium  Fish genetics

PROBLEM IV: Strengthening of Auburn University's International Aquacultural Network (IAN)

Background: The IAN is a directory of specialists in aquaculture, aquatic ecology and fisheries biology worldwide. It is an effort to join the talents and experiences of Auburn alumni in the U.S. and eighty-nine other countries and other international specialists to extend appropriate aquacultural technology to producers of various socio-economic strata in many countries. The database includes fields of specialization, professional experience, education, employment, language abilities and other critical information. The directory is continuously updated. The network was considered especially useful for those working in developing countries where access to other aquacultural specialists is very limited. Support for this activity is shared between the Cooperative Agreement and the Jack and Mary Tankersley Endowment.
Strategy for addressing problem: In 1989 an ICAAE staff member with appropriate skills and experience (Mr. A. Bocek) received Cooperative Agreement support for this task. New computer hardware was purchased with earnings from the Jack and Mary Tankersley Endowment. In 1990, a draft IAN directory containing biodata of approximately 370 Auburn alumni was prepared. In 1991, Mr. Bocek printed and distributed hardcopies of the directory to directory members, updated the database to include more than 900 alumni, and began discussions to include the IAN database in a more comprehensive university database.

Problem IV. Objective: Model and develop program and manual to make the IAN database more user friendly

IAN alumni database program development was completed in 1992. Negotiations were finalized with Auburn University Alumni Center to incorporate the files in their more comprehensive database. The database file on ICAAE/FAA alumni has been very useful in producing mailing lists and developing regional statistics about alumni with aquacultural training; however, the demand for the portion of the database containing detailed personal/technical biodata on alumni has been less than originally anticipated. After completing the ambitious program, ICAAE staff concluded that the complexity of the database to permit sorting by such a large number of biographical variables exceeded our needs and financial ability to maintain. Consequently, database effort was refocused in 1992 to cataloging contributions to the technical literature by alumni, rather than biodata and expertise of IAN members. Two supplemental IAN database files were completed in 1992: one containing the citations of more than 1,000 scientific articles authored by ICAAE/FAA staff, and a second file containing the citations and abstracts of all theses and dissertations completed since the creation of the Department of Fisheries and Allied Aquacultures. These files will be periodically updated in the future as an ICAAE activity funded through the Jack and Mary Tankersley Endowment.

PROBLEM V: Administration of Cooperative Agreement

In October of 1989, Auburn University formally established the position of Director of the ICAAE and funded this position from university resources. Among the duties of the ICA Director is administration of the Cooperative Agreement.

Problem V. Objective: Plan, manage and report Cooperative Agreement activities

In 1992, Cooperative Agreement management included development of workplans, supervising the work of graduate assistants and staff funded by the Cooperative Agreement, monitoring of overall progress toward achievement of workplan objectives, and reporting Cooperative Agreement activities and achievements. A plan for the orderly phase-out of the Cooperative Agreement was developed and submitted to AID; the proposed plan incorporated partial salary support during 1993 of key staff previously funded through the Cooperative Agreement for whom alternative support is not yet identified.

RELATED ACTIVITIES IN FISHERIES AND AQUACULTURE

A number of activities were undertaken in 1992 that did not receive Cooperative Agreement funds, but which complemented Cooperative Agreement tasks and objectives.
Research: In 1992, 22 major research projects consisting of 125 discrete subprojects were undertaken by faculty, staff and graduate students of the Department of Fisheries and Allied Aquacultures (Attachment 7). Many have potential applications for aquaculture and fisheries in developing countries. Foreign graduate students participated in this research and incorporated results into M.S. theses and Ph.D. dissertations.

Teaching: Courses in which the majority of the registered students are oriented towards international fisheries and aquaculture were taught in the departments of Fisheries and Allied Aquacultures (Attachment 8), Agricultural Economics and Rural Sociology and Agricultural Engineering.

Short-term technical assistance: Associates of the ICAAE respond to AID missions, LDC's, NGO's, PVO's and private industry requests for consultation and technical assistance. In 1992, international short-term work assignments undertaken by ICA Associates totaled 634 person-days of effort (Attachment 9). Sixteen individuals participated, 13 of whom are full-time, permanent employees of the university. Seventeen countries were visited in Africa (7), Asia (6), and Latin America (4).

Publications: Research, development and extension activities in the Department of Fisheries and Allied Aquacultures resulted in 43 new publications in 1992 (Attachment 10). The Department of Fisheries and Allied Aquacultures received 1,592 requests for technical publications in 1992; 669 were from foreign countries. We sent 5,212 publications, of which 2,261 were to international addresses. A list of publications from 1936 to 1991 for the Auburn University Department of Fisheries and Allied Aquacultures and the International Center for Aquaculture was included in the 1990 Annual Report of the Cooperative Agreement.

International Contracts and Grants:

1. During 1992, Auburn participated in the AID-funded Pond Dynamics/Aquaculture Collaborative Research Support Project (CRSP) under subcontract to Oregon State University. One ICAAE Associate (Dr. D. Teichert-Coddington) headed up this effort as resident scientist in Honduras, and another ICAAE Associate (Ms. K. Veverica) performed a similar function in Rwanda. Through 1992, and into 1993, negotiations were under way for a Pond Dynamics/Aquaculture CRSP in Egypt. A subcontract through the University of Oregon has been finalized, and a third ICAAE Associate (Dr. B. Green) will serve as resident Research Associate for the Egypt CRSP.

2. Auburn University completed the USAID/Indonesia-funded Fisheries Research and Development Project in 1992. During the final year, 155 person-days of short-term technical assistance were provided by 6 ICAAE Associates.

3. In June, 1992, ICAAE completed a Program Support Grant (PSG) awarded to Auburn University by AID/Washington. This grant was extremely useful in providing partial support to critical international program areas for which other sources of funding were not normally available or were inadequate.

4. Auburn University was subcontracted by Development Alternatives International (DAI) to participate in the implementation of USAID-funded Natural Resources Management Project in Rwanda. Three ICAAE Associates provided 59 person-days of short-term technical assistance in 1992 to conduct aquatic environmental assessment, market analyses, and evaluation of the aquacultural status in the country. ICAAE participation in the disciplines of fish production technology, environmental impact assessment, and national aquacultural planning, will continue into 1994.
5. In 1992, a $246K Basic Ordering Agreement was negotiated between Auburn University and USAID/Philippines to conduct a multi-disciplinary assessment of the prawn industry in that country. The Agreement provided 212 person-days of effort from four US consultants (including 112 person-days of effort from three ICAAE Associates) and 315 person-days of effort from five Filipino consultants. Major emphasis was on economic assessment, but production technology, marketing, environmental impact, and supporting infrastructure were also analyzed. The final draft of the report was submitted in 1992, with final revision to be provided to USAID/Philippines in early 1993.

6. The University of Georgia, with a AID-funded planning grant, requested assistance of Auburn University and other universities in the design of a proposal for a "Sustainable Agriculture and Natural Resource Management (SANREM) CRSP, most specifically in the areas of environmental impact assessment of aquatic resources and sustainable aquacultural production. USAID awarded the contract to this consortium in 1992, and negotiations for a subcontract with Auburn University were nearly completed in late 1992.

In view of the scheduled termination of the Program Support Grant and Cooperative Agreement in 1992, the ICAAE placed special emphasis on identification of other means to contribute to international development of living aquatic resources. Numerous proposals have been submitted to international agencies and national organizations supporting international development. The most significant of the USAID-related project development efforts in 1992 were:

1. The ICAAE invested considerable effort in 1992 to investigate opportunities for international activities in the management of living aquatic resources through the World Bank, African Development Bank, Asian Development Bank, and the Interamerican Development Bank. Opportunities appear promising, but no contracts were finalized in 1992. This effort will continue in 1993.

2. A proposal was submitted by Auburn University to Alabama Department of Environmental Management (ADEM) to conduct environmental education in Alabama. The $133K, 18-month grant was awarded by ADEM through EPA for implementation of the program beginning in early 1993. One of the objectives of EPA is to evaluate this effort as a model for international application.

3. A proposal for AID University Development Linkage Project (UDLP) entitled "Natural resource management, food production and environmental preservation for the forest hilltribes of northern Thailand" was submitted to AID/W in 1992. Proposed linkage was with the University of Tennessee and in Thailand with Chiang Mai University, Kasetsart University and the Asian Institute of Technology. Environmental assessment, forestry, water management/irrigation, aquaculture, animal husbandry, crop production, sociology, and economics were the proposed linkage disciplines. The proposal was not accepted for funding.

4. Under Basic Ordering Agreement DAN-4180-B-00-8009-00, Auburn University was contracted to assess the historical development of aquaculture in Jamaica and provide recommendations for continued growth in conformity with GOJ agricultural strategy. A three-person consultant team visited Jamaica in August 1990 and included an aquaculturist, an agricultural economist and a rural sociologist. The report "Jamaica aquaculture industry assessment" was submitted to the Jamaica Mission in November 1990. In 1991 a concept paper "In support of aquacultural development in Jamaica for export and local consumption" was submitted to the Mission. It described activities considered appropriate for Jamaica that could be implemented through the ICA. Discussions continued in 1992, but a contract does not appear imminent.
EXPENDITURE REPORT

In 1992, $265,031 were expended against planned expenditures of $282,646. Salaries were underspent by 11% due primarily to salary savings while Dr. Deutsch was on short-term assignment on another USAID-funded project and Dr. Popma was partially salaried from a University teaching account.

Distribution of Cooperative Agreement funds to each of the five problems (Research, Technology Transfer, Training, Networking and Administration) agreed closely to that planned and presented in the 1992 Workplan Cooperative Agreement Budget summary. Unexpended funds from 1992 ($17,615 or approximately 6% of the planned budget) were carried over into 1993 to bridge salaries of key staff previously supported through AID programs.

Actual and planned expenditures of Cooperative Agreement grant funds for calendar year 1992 were:

<table>
<thead>
<tr>
<th></th>
<th>Actual</th>
<th>Planned</th>
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<tbody>
<tr>
<td><strong>Salaries</strong></td>
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<tr>
<td>Administrative</td>
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<tr>
<td>Faculty</td>
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<tr>
<td>Secretarial/Clerical</td>
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<tr>
<td>Graduate Assistant &amp; Student Wages</td>
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<td>Other Personnel</td>
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<td><strong>Subtotal</strong></td>
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<td>Fringe Benefits</td>
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<td><strong>Total Salaries/Benefits</strong></td>
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<td><strong>Travel</strong></td>
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<tr>
<td>In-state</td>
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<tr>
<td>Out-of-state</td>
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<td>Foreign</td>
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<td><strong>Other Direct Costs</strong></td>
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<tr>
<td><strong>Indirect Costs</strong></td>
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<tr>
<td><strong>TOTAL</strong></td>
<td>$265,031</td>
<td>$282,646</td>
</tr>
</tbody>
</table>
ATTACHMENTS


5. Africa: aquatic sector assessment (questionnaires)

6. Aquaculture Training Program (ATP) brochure for 1992

7. Annual Research Summary, 1992, Department of Fisheries and Allied Aquacultures, Auburn University

8. Undergraduate and graduate curriculum, 1992, Department of Fisheries and Allied Aquacultures, Auburn University


10. Technical Publications, 1992, Department of Fisheries and Allied Aquacultures, Auburn University

11. International Center for Aquaculture and Aquatic Environments, Auburn University