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ANNUAL REPORT FOR FY 1975

THE INTERNATIONAL CENTER FOR AQUACULTURE

Auburn University Agricultural Experiment Station
Auburn, Alabama 36830

E.W. Shell, Director
Project: AID/csd-2780

December 23, 1975

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211(d) Annual Report
Date December 23, 1975

Title: To Strengthen Specialized Competency in Aquaculture, Specifically the International Center for Aquaculture
Grantee: International Center for Aquaculture
Auburn University, Auburn, Alabama
Director: Dr. E.W. Shell

AID Sponsoring Technical Office: Agriculture

A. Statistical Summary:

Period of Grant: June 25, 1970 to June 30, 1975 Amount of Grant $800,000 Expenditures for Report Year $170,432.18. Accumulated $800,000 Anticipated for next year $274,000

B. Narrative Summary:

Grant funds were utilized to purchase 44.2 man-months of academic staff time, 30.6 man-months of secretarial time, 19.5 man-months of graduate reserch assistant time and 47.9 man-months of student and field labor. The Grant-funds staff and support personnel produced 37 publications.

Library acquisitions with grant funds included 87 books and 55 periodicals. Five of the grant-funded acadmeic staff taught six academic courses during the year. A total of 566 students (385 Americans and 181 foreign students) were enrolled in courses taught at the Center. Twenty-seven students (13 American and 14 foreign) were awarded graduate degrees during the year.

Approximately 59 visitors came to the Center on business related to international development. The visitors came from 14 different countries. Special tours, demonstrations and seminars were arranged for several of them. A number of Peace Corps Volunteers visited the Center before going abroad to their assignments.

Grant-funded staff participated in approximately 7.4 man-months of international service activities over-seas during the year. They also provided 10.9 man-months of campus coordination for AID Mission-funded projects in Brazil, El Salvador, Panama and the Philippines. Other Center personnel participated in 8.7 man-months of international service activities over-seas.

I. General Background and Description of Problem

Aquaculture is becoming increasingly important in developing countries as a means of providing larger quantities of the protein needed for more adequate diets and as an important contribution to economic growth. It utilizes infertile lands and runoff waters plus agricultural wastes and surpluses to intensively grow crops of high quality proteins in the form of fish and other aquatic animals, thus greatly increasing the ability of each country to supply the protein needed by its own people. Aquaculture can be used to grow high quality protein locally where it is most needed, thus reducing the cost of transportation, processing and refrigeration. It also provides additional needed income and employment for farmers.

Auburn University has received worldwide recognition for its leadership in warmwater fisheries generally and aquaculture specifically. The University has committed itself to assist developing nations to increase their supplies of high quality protein and improve their economic well-being through improved methods of aquaculture. No other American University presently has the capability of providing this type of assistance.

This Grant was awarded to Auburn University to strengthen its research, teaching, extension and to improve the Center's service capabilities in aquaculture. As a consequence, more significant contributions can be made by the University in promoting aquaculture in developing countries. In addition, the Grant can be used to develop methods and procedures for making the University's competence in aquaculture more readily available for those who need it.

II. Purpose of the Grant

Auburn University proposes, with support from the Agency for International Development, to strengthen its International Center for Aquacultures, including its research, training, consultation and service capabilities in this field. This increased competence will enable the University to be of greater service both within the United States and to USAID, other foreign assistance agencies and developing countries.

III. Objectives of the Grant

A. Objectives Restated

Recognizing that flexibility must be maintained in planning the five-year program, the following objectives are considered of paramount importance in strengthening the competence of the International Center for Aquaculture at Auburn University.

1. To add to the faculty, experts with competence in selected fields so as to provide broader technical assistance in aquaculture in developing nations.

2. To develop a library containing worldwide literature on aquaculture and more effective methods of dissemination of information on aquaculture.

3. To provide training and educational opportunities through short courses, symposia, and University courses for professional staff members of USAID other federal agencies, and private foundations, for students interested in careers in international development, for Peace Corps Volunteers, and for foreign nationals.

4. To develop a worldwide collection of data on important food fishes and other aquatic organisms presently cultured or that appear suitable for culture.

B. Review of Objectives

The four primary objectives as approved in the Grant proposal are still appropriate to the goal of strengthening the International Center for Aquaculture at Auburn; however, as specific phases of each objective have been completed, or the relative importance of an objective has diminished, emphases have been re-directed to other priority areas.

> Objective 1. To add to the faculty, experts with competence in selected fields so as to provide broader technical assistance in aquaculture to developing nations.

Under Objective 1, in the first year, of the Grant a core of expertise was established in the various aspects of aquaculture. Since then this coure staff has been involved in research, training and extension in aquaculture.

This objective has been the primary one from the beginning of the Grant. Special emphasis has been given to aspects of aquaculture that are of greatest importance in the solution of problems in developing countries. Because of funding limitation the size of the core-staff has remained relatively static since the beginning; however, numerous changes have been made in the composition of the staff comprising the core. Scientists brought to the campus as part of the core-staff have been shifted partially and then completely to other projects as the over-all fisheries and aquaculture program of the University has developed. Also, relatively few of the core-staff have been funded entirely from the Grant. Generally they have held joint appointments between the Grant and other projects. These joint appointments have resulted in a larger number of scientific specialties being represented on the core-staff than would be possible otherwise. In the past fiscal year seven different scientists representing seven scientific specialties related to aquaculture comprised the core-staff.

Objective 2. To develop a library containing worldwide literature on aquaculture and more effective methods of dissemination of information on aquaculture.

Less attention has been devoted to Objective 2 this past fiscal year than in previous years. Most of the relevant books and journals available were purchased in the first four years of the Grant. New materials published during the year were added to the collection. A number of older but important reference books were located and purchased. These materials have been catalogued and included in the regular holdings of the University Library where they are available to all students and staff for study. Materials sent to the International Center from other countries on an exchange basis have been placed in the collection maintained by the Center.

No progress has been made in developing more effective methods of dissemination of information on aquaculture. It is becoming increasingly clear that this part of Objective 2 cannot be effectively accomplished without

additional funding, staff and mechanisms for dissemination. Dissemination of information is an important aspect of international aquacultural development, but to accomplish it will require more emphasis and effort than is possible under the present Grant.

> Objective 3. To provide training and educational opportunities through short courses, symposia and University courses for professional staff members of USAID other Federal agencies and private foundations, for students interested in careers in international development, for Peace Corps Volunteers and for foreign nationals.

Considerable effort has been devoted to this objective. Training and education have probably required more staff time than either expansion of the knowledge base, advisory services or extension. Developing countries, through USAID support have benefitted greatly from efforts in this area. Approximately one-half of our entire graduate training program involves foreign nationals who have come to Auburn to study aquaculture and fisheries.

> Objective 4. To develop a world-wide collection of data on important food fishes and other aquatic organisms presently cultured or that appear suitable for culture.

This objective has received relatively little specific attention, although additions to the Library under Objective 2 have emphasized data on important or potentially important food fishes. Here as in the case of Objective 2 little consideration was given initially to planning or implementing a utilization mode for information collected. This information is used by graduate students in their research reviews and by staff in preparation for short-term surveys and technical assistance projects, but we have no mechanism for making the information available directly to developing countires.

IV. Accomplishments

There were accomplishments on all objectives of the Grant however the most significant accomplishments were under Objectives 1 (addition of staff and the related expansion of the knowledge base) and 3 (training).

A. Accomplishments on Objective 1 (to add to the faculty, experts with competence in selected fields so as to provide broader technical assistance in aquaculture in developing nations)

Grants funds were utilized to purchase 121.1 man-months of personal services of staff time for the International Center during the past year. A list of the various staff members and the percentage of their time purchased by Grant funds is presented in Table 1. The composition of staff time purchased was as follows:

Category	Man-months
Academic and Research	44.2
Technical and Secretarial	30.6
Graduate Research Assistants	19.5
Field and Student Labor	26.8
Total	121.1

Man months of personnel services purchased with grant funds since the beginning of the project are given in the following table:

Year	Category of Personnel			
	Academic and Research	Technical And Secretarial	Grad. Res. Assistants	Field and Student Labor
1970-1971 (FY 1971)	47.8	12.0	15.2	17.6
1971-1972 (FY 1972)	38.0	22.3	25.6	74.9
1972-1973 (FY 1973)	45.2	16.1	16.3	65.6
1973-1974 (FY 1974)	48.4	29.0	22.4	47.9
1974-1974 (FY 1975)	44.2	30.6	19.5	26.8
	223.6	110.0	99.0	232.8

The Grant-funded staff participated in all activities of the Center but their primary accomplishments related to Objective 1 was in expansion of the knowledge base through research and development. The senior staff participated directly in approximately 30 research and development projects during the year. A summary

of research accomplishments is presented in Appendix V. Graduate research assistants paid from Grant funds contributed directly to an additional 9 projects. Staff activities resulted in 37 publications during the year. These are listed in Appendix I.

The number of publications produced by grant-funded staff since the beginning of the Grant is shown in the following table:

Year	Number
1970-1971 (FY 1971)	6
1971-1972 (FY 1972)	8
1972-1973 (FY 1973)	12
1973-1974 (FY 1974)	13
1974-1975 (FY 1975)	37[1/]
	76

Accomplishments on Objective 1 also included a number of international service activities by the Grant-funded staff. They participated in 7.7 man-months of activities overseas and contributed 10.9 man-months of technical backstopping at Auburn for four USAID Mission funded projects.

Man months of overseas activities by grant-funded staff since the inception of the grant are given in the following table:

Year	Man-months
1970-1971 (FY 1971)	9.8
1971-1972 (FY 1972)	8.0
1972-1973 (FY 1973)	3.0
1973-1974 (FY 1974)	4.5
1974-1975 (FY 1975)	7.7
	33.0

B. Accomplishments on Objective 2 (to develop a library containing literature on aquaculture and more effective methods of dissemination of information on aquaculture)

1/ Beginning in Fy 1975 formal reports prepared as a result of USAID contracts are included in the number of publications.

Additions to the library were continued this year. Grant funds were utilized to purchase 87 books and 55 periodicals. Emphasis on Library purchases was on materials dealing with the fish, aquaculture and fisheries of foreign countries.

Because of the costs involved little progress was made in developing more effective methods of dissemination of information on aquaculture. The Center maintains an up-to-date list of its own publications. The list contains approximately 290 items on various aspects of inland fisheries and aquaculture. Periodically the list is sent to approximately 275 persons on our mailing list, including approximately 100 persons from foreign countries. Recipients of the publication list indicate by return mail those wanted. The publications are sent without charge.

C. Accomplishments on Objective 3 (to provide training and educational opportunities through short courses, symposia, and University courses for professional staff members of USAID, other federal agencies, and private foundations, for students interested in careers in international development, for Peace Corps Volunteers, and for foreign nationals)

There were significant accomplishments on Objective 3 during the year. Five of the staff members on the Grant taught a total of six regular University courses. University teaching funds paid for the actual instructional time; however without the Grant funds those staff members would not have been available for use in the courses. Information on courses taught by the staff and graduate students supervised by them is presented in Table 1.

The number of courses taught by grant-funded staff since the inception of the grant is shown in the following table:

Table 1. Courses taught and graduate students supervised by Grant-funded staff.

Professors	Courses Taught	No. of Graduate Students Supervised
Dr. E. W. Shell	None	3
Dr. D. D. Moss	Pond Construction	0
Dr. R. Allison	None	4 (4)[1]
Mr. J. R. Hubbard	Extension methods	0
Dr. R. T. Lovell	Fish nutrition and fish processing technology	16(14)
Dr. E. W. McCoy	Aquacultural economics	2(1)
Dr. M. M. Pamatmat	None	4(3)
Dr. R. O. Smitherman	Aquaculture	10(4)
Mr. R. K. Goodman	None	0
Ms. E. W. Scarsbrook	Nutrient cycles in aquaculture	0

[1]Number in parenthesis indicates number of graduate students that were foreign nationals.

Year	Number of Courses
1970-1971 (FY 1971)	6
1971-1972 (FY 1972)	7
1972-1973 (FY 1973)	8
1973-1974 (FY 1974)	9
1974-1975 (FY 1975)	6
	36

The staff also contributed to the training and orientation of 59 visitors who came to the Center during the year. A list of the visitors is presented in Appendix II.

The number of visitors coming to the center specifically for information on international fisheries and aquaculture development each year since the inception of the grant is shown in the following table:

Year	Number of Visitors
	1/
1970-1971 (FY 1971)	
1971-1972 (FY 1972)	41
1972-1973 (FY 1973)	30
1973-1974 (FY 1974)	58
1974-1975 (FY 1975)	59
	188

The International Center utilized Grant funds to bring the following scientists to campus to present seminars and to consult with staff and graduate students:

Mr. Randy Hagood. Research scientist with the Florida Department of Natural Resources. Mr. Hagood is an expert on the culture of brackishwater shrimp.

Dr. Marcel Huet. World-renowned expert in aquaculture from Belgium. Dr. Huet presented several lectures on various aspects of aquaculture while at Auburn.

1/ Records not kept for FY 1971

Dr. Fred Lee. Dr. Lee is an expert in water quality and a member of the research staff at the University of Texas at Dallas.

Dr. S. W. Ling. Dr. Ling is an expert in tropical aquaculture. Before retiring he was FAO Regional Fish Culturist for Asia and the Far East.

D. Accomplishments on Objective 4 (to develop a worldwide collection of data on important food fishes and other aquatic organisms presently cultured or that appear suitable for culture)

Relatively little effort was devoted to this objective during the year. We are continuing to collect data on fish and aquatic organisms that appear suitable for culture, but because of the cost involved and the difficulty experienced in obtaining the data collections are not being made on a systematic basis.

V. Impact of Grant Supported Activities in Achieving Grant Purpose

The purpose of the Grant is to strengthen the International Center for Aquaculture for greater service to developing countries. It is evident from the information presented in Section IV (Accomplishments) that reasonable progress is being made in the use of Grant funds to realize the Grant purpose. The International Center has been strengthened and the resulting capability for service is being maintained and enhanced. Furthermore the increased capacity is being effectively utilized.

Grant funds were utilized during the year to purchase 121.1 man-months of personnel services. These services contributed significantly to the capability of the Center in the areas of education and training, extending the knowledge base, advisory capacity, information capacity, and linkages and networks. Funds were also used to increase library holdings, to support the activities of the Center staff and to provide materials, supplies and minor items of equipment utilized in graduate training.

The major contribution of the Grant was to provide for the purchase of approximately 38 man-months of senior-level (assistant professor and above) staff during the year. These personnel are key elements in the strengthening of the International Center. they are primarily responsible for the training, extension of the knowledge base, advisory services and other activities necessary for a vital program.

Virtually all of the Grant-funded staff participated in the expansion of the knowledge base through research and development. Results of their activities were published as research papers in recognized scientific journals, as chapters in monographs or books, as part of symposia and as reports prepared for various USAID Missions and International Development Agencies.

Presented in Table 2 is a list of the Grant-funded staff indicating

research interests, the number of research projects in which they participated and the number of publications resulting from their activities. Titles of the various publications are presented in Appendix I.

Of special significance in the expansion of the knowledge base through the use of Grant funds was the research conducted by foreign students. Not only did they contribute new information to various fields of aquaculture and inland fisheries, but they also learned something of the use of the scientific method for solving practical problems. A total of 14 foreign students received graduate degrees during the year. Each student was required to submit a thesis or dissertation based on original research. Although none of these students were supported directly on Grant funds, all utilized equipment and supplies, benefited from the availability of field labor or received guidance and information from staff time which was purchased with Grant funds. Names, country of origin and title of the thesis or dissertation for each student are presented in Table 3.

Because of the availability of the staff funded from the Grant, the Department has been able to attract a number of research grants and contracts that it could not otherwise have handled. In the past year the Grant-funded Staff was involved in a number of research projects supported by State appropriated University funds. Several of these research projects will result in information that will have direct transferability to developing countries.

Grant-funded Staff taught six courses during the year. The University paid most of the costs for teaching the courses, but because of the use of the Grant funds, more specialists were available for teaching these courses. Nine courses per 12-month academic year would be approximately a full-time teaching load for one professor if he were supported entirely by University teaching funds.

Table 2. Research interests, research projects and publications of the Grant-funded staff.

Name	Research interests	No. of Research Projects	No. of Publications[1/]
Dr. E. W. Shell	Aquaculture	1	0
Dr. D. D. Moss	Aquaculture	0	6
Dr. R. Allison	Aquaculture	4	3
Dr. R. T. Lovell	Fish nutrition and fish processing and technology	6	9
Dr. E. W. McCoy	Aquacultural economics	3	6
Dr. M. M. Pamatmat	Pond ecology	2	2
Dr. R. O. Smitherman	Aquaculture	5	2
Mr. J. R. Snow	Aquaculture and fish reproduction	2	7
Dr. W. D. Davies	Fisheries management	5	3
Mr. R. D. Goodman	Aquaculture	1	0
Ms. E. W. Scarsbrook	Pond ecology	1	1
Mr. D. E. Alston	Culture of fish food organisms (with Dr. J. S. Dendy)	1	1[2/]
Mr. R. L. Busch	Induced spawning of fish (with Dr. W. L. Shelton)	1	0
Mr. J. A. chappel	Quantitative inheritance in fish (with R. O. Smitherman)	1	0
Mr. C. Lim	Nutrient requirements of fish (with Dr. R. T. Lovell)	1	0
Mr. V. E. Mezainis	Oxidation of organic matter in fish culture ponds (with Dr. M. M. Pamatmat)	1	0

1/ Titles of publications are given in appendix

2/ Research thesis or dissertation

Table 2. (Continued)

Name	Research Interests	No. of Research Projects	No. of Publications
Mr. P. W. Perschbacher	Effect of grazing by *Tilapia* or productivity of phytoplankton (with Dr. C. E. Boyd)	1	1
Mr. R. P. Phelps	Toxicity of disease control chemicals to fish (with Dr. W.A. Rogers)	1	1[2]
Mr. E. H. Robinson	Nutrient requirements of cultured fishes (with Dr. R. T. Lovell)	1	0
Mr. C. S. Tucker	Prevention of oxygen depletion following plankton die-offs (with Dr. C. E. Boyd)	1	0
Mr. J. L. Williamson	Competition for food in polyculture (with Dr. R. O. Smitherman)	1	1[2]

Table 3. Titles of theses and dissertations written by foreign students.

Name	Thesis or Dissertation Title
Almazan, Guadiosa (Philippines)	Studies on oxygen consumption by microbial organisms during decomposition of aquatic plants. (Boyd)
Apolinario, Catherine (Philippines)	Recovery and utilization of boneless flesh mechanically separated from Tilapia (Tilapia aurea), buffalofish (Ictiobus cyrpinellus x Ictiobus niger), channel catfish (Ictalurus punctatus). (Lovell)
Arce, Rodolfo (Philippines)	Effects of applications of agricultural limestone on water chemistry, phytoplankton, productivity, and tilapia production in softwater ponds. (Boyd)
Augusto, Jose (Brazil)	Effects of inorganic fertilization on phytoplankton in fed catfish ponds. (Boyd)
Boonyaratpalin, Mali (Thailand)	Development of flaked feeds for aquarium fish. (Lovell)
Boonyaratpalin, Sitdhi (Thailand)	Movement of largemouth bass in relation to a thermally influenced area on the Coosa River. (Shelton)
Camacho, Arsenio (Philippines)	Characterization of thiamine deficiencies in channel catfish fed heated and nonheated catfish processing wastes. (Lovell)
Dcla Cruz, Catalina (Philippines)	The effect of water circulation and aeration on water quality and productivity of catfish in a closed system. (Allison)
Fortes, R. D. (Philippines)	Studies on chlorophyll in pond waters. (Boyd)
Hongpromyart, Manoj (Thailand)	Population sturcture and dynamics of a dominant black crappie (pomoxis Nigromaculatus) year class in Lee County Public fishing Lake, Ala. (Davies)
Koonsoongnoen, Vanida (Thailand)	Protein efficiency ratios of catfish processing wastes for channel catfish fingerlings. (Lovell)

Table 3. (Continued)

Name	Thesis or Dissertation Title
Potipitak, Kumron (Thailand)	Standing crop of oligochaetes outside culture pens of channel catfish. (Pamatmat)
Sirikul, Boonsong (Thailand)	Conditions changes in harvestable size channel catfish held in ponds overwinter under various feeding regimes. (Lovell)
Tangtrongpiros, Manob (Thailand)	Effects of stocking rates of channel catfish on standing crops of oligochaeta (Annelida). (Pamatmat)
Ventura, Rudy (Philippines)	A survey of methods in artificial breeding of grass carp. (Shelton)

Obviously, a single individual could not adequately teach the wide variety of courses offered. By combining University teaching funds and Grant funds into joint appointments, seven different teachers (specialists in their respective fields) were available to teach the courses.

A summary of the information on courses taught and students enrolled is presented in the following table:

Quarter	No. of Courses	Number of Students Enrolled[1/]	
		American	Foreign
Summer, 1974	8	50	43
Fall, 1974	10	93	47
Winter, 1975	11	157	67
Spring, 1975	9	85	24
Total	40	385	181

The graduate training program increased dramatically during the year. In FY 1974 only 16 new graduate students were admitted to the program. In the past year (FY 1975) 33 new students were enrolled. A significant factor in the increase was enrollment of former Peace Corps Volunteers. The Volunteers enrolled after completing tours of duty overseas where they participated in aquaculture and inland fisheries projects. Grant-funded staff served as major professors for 14 of the new students.

Including the new students admitted during the year, an average of 60 graduate students were enrolled in the Department during each of the four quarters. Because of the program established through use of the Grant funds, the graduate enrollment has increased almost three-fold since 1970. Numbers of graduate students enrolled in each of the qurters for the period since the inception of the Grant are shown in the following table:

[1/] Students take more than one of the courses each quarter.

Year	Number of Graduate Students Enrolled in each Quarter			
	Summer	Fall	Winter	Spring
1970-1971 (FY 1971)	24	23	31	28
1971-1972 (FY 1972)	29	34	43	46
1972-1973 (FY 1973)	43	48	50	51
1973-1974 (FY 1974)	48	57	54	53
1974-1975 (FY 1975)	50	57	65	69

Foreign graduate student enrollment has also increased dramatically since the inception of the Grant. Information on the enrollment of these students is presented in the following table:

Year	Number of Foreign Graduate Students Enrolled each Quarter			
	Summer	Fall	Winter	Spring
1970-1971 (FY 1971)	7	5	5	7
1971-1972 (FY 1972)	5	5	13	15
1972-1973 (FY 1973)	16	16	19	22
1973-1974 (FY 1974)	22	27	26	26
1974-1975 (FY 1975)	24	22	19	21

A total of 27 advanced degrees were awarded during the year (24 M.S. and 3 Ph.D.). Fourteen of the degrees were awarded to foreign students. Information on the total number of advance degrees awarded and the number awarded to foreign students is presented in the following table:

Year	Graduates	
	M.S.	Ph.D.
1970-1971 (FY 1971)	4(0)[1/]	4(2)
1971-1972 (FY 1972)	10(4)	4(1)
1972-1973 (FY 1973)	18(8)	4(0)
1973-1974 (FY 1974)	20(9)	5(3)
1974-1975 (FY 1975)	24(12)	3(2)
	76(33)	20(8)

1/Number of foreign student graduates given in parenthesis.

VI. Other Resources for Grant-Related Activities

All funds received by the Department and International Center strengthen and support the Center. Information on the various sources of funds is presented in Table 4. As the information indicates, the Department and Center receive funds from a wide variety of sources; however USAID is the largest single source of funds. Appropriated funds from the State of Alabama to Auburn University for teaching and research represent the second largest source of funds. A number of separate research and development contracts provide the third largest source.

Interpreting the term, grant-related activities, in it's broadest sense, virtually all funds received contribute directly or indirectly to achieving the purpose of the grant. Even industrial research grants contribute supplies, equipment and personnel that are used to some extent in graduate training. By having this type of work going on in the same Department foreign graduate students are able to better comprehend the complexity of problems they must face in the future when attempting to balance food and industrial production needs with the need for environmental protection.

Table 4. Sources and amounts of funds available for grant-related activities.

Source of Funds	Amount
State of Alabama appropriated funds	
For teaching	$ 145,333
For research	124,946
Sales funds	
For sale of food fish and fingerlings	237,168[1/]
Federal appropriated funds for research	
USDA - Land-Grant College funds	73,274
Research grants from other State governments	114,127
Research grants from Federal agencies	69,452
Research grants from private enterprise	144,786
Sub Total	909,086
All USAID support	462,685
Total	$1,371,771

1/ Includes $213,811 for sale of timber. This was a one-time sale and will not be repeated for 15-20 years.

VII. Utilization of Institutional Response Capabilities in Development Programs

Some information on international service activities has previously been presented in Section IV (Accomplishments). Additional information is presented in Table 5.

A primary activity of the International Center for Aquaculture is international service activities. In the past year staff of the Center participated in a total of 459 man-days of service activities overseas. Grant-funded staff and other staff supported with Grant-funds were involved in 262 man-days or approximately 60 percent of these activities.

The international service activities can be roughly divided into four categories. The different categories along with the number of man-days of each were as follows:

Category	Man-Days
Activities by Grant staff utilizing 211-d funds	31
Activities by other staff utilizing 211-d funds	37
Activities by Grant staff utilizing other funds	194
Activities by other staff utilizing other funds	228
	490

Lists of the activities by category are presented in Tables 5-8. Also included in the tables are names of the staff involved along with dates for each activity.

In addition to the International Service activities discussed above the Center also provided 60.5 man-months of technical assistance to four international development projects overseas. Center staff were assigned to these projects full time. These projects were: (1) A USAID supported freshwater aquaculture development project in Northeast Brazil (AID/la 1152

Table 5. International service activities of Grant staff ucilizing 211-d funds

Professor	Activity and Dates
D. D. Moss	Consultations with USAID Missions in Colombia, Costa Rica and Panama on aquaculture and fisheries programs. January 5 - January 22, 1975.
M. M. Pamatmat	Gave invited lecture on aquatic ecology at meeting on meiofauna at Bordeaux, France. September 23 - September 29, 1974.
J. R. Snow	Attended Conference on "Fish Farming in Europe" in London. December 1 - December 6, 1974.

Table 6. International service activities of other staff utilizing 211-d funds

Professor	Activity and Dates
M. C. Johnson	Assisted Government of Colombia and USAID Mission in Bogota in development of plans for an aquaculture research station. March 16 - March 21, 1975.
E. E. Prather	Conducted a survey on aquaculture potential in Jamaica. June 17 - June 29, 1974.
D. G. Hughes	Participated in FAO-sponsored Aquaculture Conference in Montevideo, Uruguay. November 23 - December 10, 1974.

Table 7. International service activities by Grant staff utilizing other funds

Professor	Activity and Dates
E. W. Shell	Conference with Israeli scientists on Bi-National Science Foundation project on "Fish Breeding". January 6 - January 12, 1975.
	Met with FAO officials in Rome regarding program of International Center for Aquaculture. January 13, 1975.
D. D. Moss	Met with USAID and Government of Colombia officials in Bogota to discuss plans for aquaculture research station. September 29 - October 4, 1974.
	Meeting in Colombia for further discussions of plans for research stations. January 5 - January 10, 1975.
	Meeting in Colombia to review progress of construction of research station. March 16 - March 21, 1975.
	Planning for expansion of milkfish industry in Indonesia with Government and USAID officials. May 27 - June 25, 1975.
R. T. Lovell	Participated in short-course on aquaculture sponsored by Brazilian fisheries agency in Fortaleza, Brazil. March 27 - April 7, 1975.
E. W. McCoy	Participated in survey of expansion of milkfish industry in Indonesia. May 27 - June 28, 1975.
M. M. Pamatmat	Attended conference on aquatic ecology sponsored by NATO in Switzerland. November 3 - December 12, 1974.
R. O. Smitherman	Surveyed potential for shrimp culture on West Coast of Colombia. September 29 - October 11, 1974.
	Conferred with USAID Mission and Government of Panama officials on aquaculture work in that country. June 1 - June 6, 1975.
J. R. Snow	Participated in survey for expansion of milkfish industry in Indonesia. May 27 - June 28, 1975.

Table 8. International service activities by other staff utilizing other funds

Professor	Activity and Dates
M. C. Johnson	Survey of potential sites for fish farm in Mid-Western State, Nigeria. June 29 - July 19, 1975.
W. D. Davies	Study of trout production potential in natural lakes in Peruvian Andes. August 24 - September 22, 1974.
	Study of problems relating to the development of the fishery in Lake Victoria, Tanzania. October 26 - November 16, 1974.
J. H. Grover	Attended conference on brackish water shrimp culture in South Vietnam. March 30 - April 12, 1975.
	Surveyed catfish culture industry in Thailand. April 12 - April 15, 1975.
	Assisted USAID Mission in Indonesia with preparation of documentation required for proposal to provide assistance to GOI on milkfish culture. June 19 - July 5, 1975
L. L. Lovshin	Attended FAO-sponsored conference on Aquaculture in Montevideo, Uruguay. November 24 - December 3, 1974.
G. E. Hall[1/]	Evaluation of proposed USAID project for improvement of Lake Tanganyika's fishery resources in Zaire. March 9 - April 8, 1975.
J. A. Plumb	Participated in short-course on aquaculture sponsored by Brazilian fisheries agency in Fortaleza, Brazil. March 27 - April 7, 1974.
H. R. Schmittou	Conferred with USAID and Government of Indonesia officials on potential for expansion of milkfish industry in Indonesia. November 4 - November 23, 1974.
W. L. Shelton	Study of trout production potential in natural lakes in Peruvian Andes. August 24 - September 22, 1974.
J. W. Jensen	Attended FAO-sponsored conference on aquaculture in Montevideo, Uruguay. November 24 - December 3, 1974.

[1/] Mr. Hall is a staff member of the Tennessee Valley Authority.

To 2 ICA), (2) a USAID supported freshwater aquaculture development project in El Salvador (AID/la 688 ICA), (3) a USAID supported brackish and freshwater aquaculture development project in the Philippines (AID/ea 180 ICA) and (4) an aquacultural development project in Mid-western State in Nigeria. This project is supported by the Nigerian Government. Three of the Center staff receiving part of their support from the Grant provided 10.9 man-months of technical backstopping for those overseas projects. Funds from the individual projects paid for their services.

A major Center activity during the year was the training of foreign students. Table 1 includes information on the total number of graduate students supervised by each of the staff members. They were responsible for 26 different foreign graduate students during the year. Their responsibility included serving as Chairman of the graduate committee, primary responsibility for developing the plan of study and supervising the thesis or dissertation research for each student. The close and continuing contact between student and major professor is one of the most important elements in training graduate students. This contact is even more important in the case of foreign students. We are most fortunate to have the Grant-funded staff available for this service at Auburn. Because a majority of them have foreign service experience, they are able to relate to the foreign students much more effectively.

A total of 27 students were awarded advanced degrees with specialization in inland fisheries and aquaculture during the past year. Fourteen of the 27 graduates were foreign students. One of the foreign students was from Brazil, six were from the Philippines and seven were from Thailand. Thirteen of these students were provided financial support through USAID Mission programs. The fourteenth student supported himself while here.

Eleven of the graduates have returned to their respective countries and are engaged in inland fisheries and aquaculture work. One of the graduates, Dr. Arsenio Camocho, has been appointed Director of the Brackishwater Aquaculture Center at Leganes, Iloilo in the Philippines. Another, Dr. Catalino dela Cruz is Director of the Freshwater Aquaculture Center at Central Luzon State University in the Philippines. Three of the graduates are still at Auburn and are now studying for the Ph.D. degree.

Another important international service activity was providing short-term training and orientation to the large number of visitors who came to the Center during the year to obtain information on inland fisheries and aquaculture in less-developed countries and information on the program of the International Center. Information on these visitors is presented in Table 9. Names and addresses of the visitors are listed in Appendix II. Twenty-five of the 59 total visitors were from 14 foreign countries. These visitors required approximately 120 man-days of specialized training and orientation by the Center staff.

The Center provided a 4-day shortcourse for a group of 10 Peace Corps Volunteers from Michigan State University who were training for service in the Philippines. It is anticipated that this type of training will be increased in the future.

The Center also provided approximately 2 months of training in aquaculture for Dr. Abdel Kadar Dia from the Ivory Coast. Dr. Dia's training was sponsored by the Council for International Exchange of Scholars as a Fulbright-Hays Scholar.

The Center has established and is maintaining a number of linkages both domestic and international that will facilitate utilization of its unique capabilities. The more important of these linkages with respect to

Table 9. Number, country of origin and/or sponsoring organization of official visitors to the International Center for Aquaculture.

Country and/or Organization	Number
Foreign	
Philippines	5
Guatemala	4
Japan	4
Belgium	1
Burma	2
Canada	1
Chile	1
Indonesia	1
Israel	1
Ivory Coast	1
New Zealand	1
Nigeria	1
Taiwan	1
Venezuela	1
American	
USAID	7
IBRD	2
Peace Corps	10
Rockefeller Foundation	2
Oceanic Foundation	3
Other	10

immediate utilization of developed capability include:

The University of Arizona
The University of Rhode Island
The University of Puerto Rico
The University of the Philippines
Kasetsart University in Thailand
IBRD
FAO
USAID
Peace Corps
Southeast Asia Fisheries Development Council

Utilization of institutional response is expected to increase this year. New USAID Mission funded projects involving the Center are expected to develop in Jamaica, Colombia and Indonesia and there is a good possibility that a project will be initiated in Honduras and Pakistan.

The project in the Philippines will be continued but at a reduced level. The project in El Salvador will be terminated. A proposal is being prepared to convert the project in Brazil to a regional one. If this conversion is carried out, additional services from the Center will probably be required.

The initial phase of the work in Nigeria will be completed early in 1976. It is anticipated that the Center will be requested to provide additional assistance on that project during the year.

Plans are being made to hold two, 3-month shortcourses in inland fisheries and aquaculture during the coming year. The courses will be designed primarily for technical personnel working in these fields in developing countries. The courses will be publicized and applications mailed early in 1976.

VIII. Next Year's Plan of Work and Anticipated Expenditures

The original 211-d Grant was extended in June, 1975, for a 2-year period. The rather indefinite objectives of the original Grant have been replaced with more specific ones. The work planned for the coming year has been described in detail in a series of workplans submitted to AID/Washington. A summary of the planned activities is presented in Table 10.

The expected cost of the objectives/outputs in terms of effort and Grant funds is:

Objective/Output	Man-Months	Cost
Education and training	41.4	$ 65,600
Extend knowledge base	113.5	179,500
Advisory capacity	4.9	7,700
Information capacity	10.1	16,000
Linkages and networks	5.5	9,200
	173.6	$274,000

Table 10 Objectives/outputs, Categories of work and activities for the following year under the Grant.

Output I: EDUCATION AND TRAINING

Category A: Develop New Courses

Activity 1: Develop courses in fish seed production

Activity 2: Develop course in aquacultural economics

Activity 3: Develop two courses in fish genetics and breeding

Category B: Provide Practical Training

Activity 1: Develop short-courses for foreign graduate students

Category C: Develop Special Purpose Training for Short-term Visitors.

Activity 1: Develop and implement training programs to meet specific needs for short-term visitors.

Category D: Support Graduate Training

Activity 1: Support training of American and foreign graduate students who are primarily interested in aquaculture and inland fisheries development on an international basis.

Output II: EXTEND KNOWLEDGE BASE

Category A: Preparation of State-of-the-art Reports

Activity 1: Aquaculture and small-scale fisheries

Activity 2: Aquacultural economics

Activity 3: Minimum input aquaculture

Activity 4: Knowledge transfer (aquaculture extension) methodology

Category B: Expansion of Knowledge Base and Research Capability

Activity 1: Production systems

Activity 2: Pond ecology as related to algae management with copper herbicide.

Activity 3: Pond ecology as related to energy flow in aquacultural systems.

Table 10. (Continued)

Activity 4: Spawning and rearing of promising food fishes

Activity 5: Fish nutrition

Activity 6: Processing technology

Output III: ADVISORY CAPACITY

Category A: Functional Training

Activity 1: Provide functional training to certain Auburn 211-d staff.

Category B: Talent Banking

Activity 1: Develop a list of talent for work in inland fisheries and aquaculture in LDCs.

Category C: Orientation and Support

Activity 1: To provide pre-departure orientation for Auburn Staff being sent overseas.

Category D: Advisory Capacity

Activity 1: To provide limited technical back-stopping for USAID Mission-funded projects overseas

Output IV: INFORMATION CAPACITY

Category A: Information Capacity

Activity 1: To publish information resulting from all 211-d activities

Output V: LINKAGES AND NETWORKS

Category A: Linkages and Networks

Activity 1: To improve and expand linkages between the International center for Aquaculture and other International Development Agencies, both American and Foreign.

IX. Involvement of Minority Personnel and Women

Information on the involvement of minority personnel and women in Grant activities is presented in Table 11.

Auburn University has an "Affirmative Action Program" for the involvement of minority personnel and women and for recruiting students for training. The provisions of the Program are followed closely by the Center in recruiting staff and in recruiting students for graduate training.

There are excellent opportunities for involving minority personnel and women in international development work and for significant contributions to Center activites. Unfortunately very few of either group are interested in careers in fisheries and aquaculture and even fewer are interested in international service in these areas of work.

Table 11. Numbers of minority personnel and women involved in Grant activities and nature of their involvement.

Category and Name	Nature of Involvement
Women	
Ms. E. W. Scarsbrook	Research associate
Ms. C. B. Sherrer	Senior clerk
Ms. C. B. Hawke	Typist
Ms. E. C. Talley	Typist
Ms. P. M. Argo	Typist
Ms. L. S. Stonicher	Typist
Ms. T. N. Tilson	Typist
Ms. A. C. Tucker	Typist
Men	
Dr. M. M. Pamatmat (Amer. Ori.)	Senior staff
Mr. W. Pitts (black)	Field worker
Mr. L. Ray (black)	Field worker
Mr. J. Byrd (black)	Field worker
Mr. J. Ogletree (black)	Field worker
Mr. M. Washington (black)	Field worker
Mr. T. Watts (black)	Field worker
Mr. E. Dowdell (black)	Field worker

X. Utilization of Grant Funds

Tables 12 through 14 contain information on the accumulated expenditure of funds, the expenditure of funds during the current year and projected expenditure of funds for the remainder of the Grant period.

Table 12. Distribution of 211(d) Grant Funds and Contributions from other Sources of Funding*

Reporting Period July 1, 1974 to June 30, 1975

Grant Objectives/Outputs	211(d) Expenditures				Non 211(d) Funding* Amount
	Period under Review	Cumulative Total	Projected Next Year	Projected to end of Grant	
Knowledge base	126,119.81	537,349.08	179,500	916,349.08	635,086
Training	6,817.29	122,822.42	35,800	199,422.42	145,000
Libraries	5,112.96	10,046.31	3,000	16,046.31	1,000
Advisory services	28,973.47	96,955.65	45,000	191,955.65	15,000
Publications	1,565.93	14,416.09	8,700	31,816.09	7,000
Other	1,842.72	18,410.45	2,000	22,410.45	6,000
Total	170,432.18	800,000.00	274,000	1,378,000.00	809,086

*These figures are your best estimates.

Table 13. Expenditure Report, Actual and Projected

(Actual and Projected)

Under Institutional Grant #AID/csd - 2780

Review Period July 1, 1974 to June 30, 1975

(Line Items to Conform to Budget in Grant Document)	Expenditures to Date		Projected Expenditures		Total
	Period Under Review	Cumulative Total	Year 6	Year 7	
e.g. Salaries	90,085.84	372,829.41	144,000	165,000	$ 681,829.41
Travel	12,128.52[1]	36,183.09	18,000	18,000	72,183.09
Equipment	2,788.43	16,770.42	10,000	10,000	36,770.42
Personnel benefits	11,955.81	44,318.38	29,000	33,000	106,318.38
Graduate Research Assistants	16,890.83	76,416.17	30,000	32,000	138,416.17
Supplies, Library and Other	36,582.75[2]	253,482.53	43,000	46,000	342,482.53
Total	170,432.18	800,000.00	274,000	304,000	$1,378,000.00

1/ This budget category is itemized in Appendix III

2/ This budget category is itemized in Appendix IV

Table 14. Expenditure report, reporting year detail.

Part A. Names of faculty and man-months of effort charged to Grant.

Name	Position	Man-Months
Dr. E. W. Shell	Director	4.2
Dr. D. D. Moss	Assistant Director	1.3
Dr. R. Allison	Associate Professor	2.8
Mr. J. R. Hubbard	Associate Professor	1.4
Dr. R. T. Lovell	Associate Professor	2.6
Dr. E. W. McCoy	Associate Professor	2.1
Dr. M. M. Pamatmat	Associate Professor	7.2
Mr. E. E. Prather	Associate Professor	0.4
Dr. R. O. Smitherman	Associate Professor	6.9
Mr. J. R. Snow	Associate Professor	8.0
Dr. W. D. Davies	Assistant Professor	0.8
Mr. R. K. Goodman	Research Associate	0.5
Ms. E. W. Scarsbrook	Research Associate	6.0

Part B. Names of clerical personnel and man-months of effort man-months of effort charged to Grant.

Name	Position	Man-Months
Mr. B. N. Burrow	Technical Assistant	1.5
Mr. C. D. Depoister	Technical Assistant	2.3
Mr. J. P. Pugh	Technical Assistant	0.5
Ms. C. B. Sherrer	Senior Clerk	5.3
Ms. C. B. Hawke	Typist A	1.3
Ms. E. C. Talley	Typist A	9.9
Ms. P. M. Argo	Typist	0.6
Ms. L. S. Stonicher	Typist	2.3
Ms. T. N. Tilson	Typist	1.2
Ms. A. C. Tucker	Typist	5.7

Table 14. (Continued)

Part C. Names of graduate research assistants and man-months of effort charged to Grant.

Name	Position	Man-Months
Mr. D. E. Alston	Graduate Research Assistant	1.7[1/]
Mr. R. L. Busch	Graduate Research Assistant	4.0
Mr. J. A. Chappell	Graduate Research Assistant	0.7
Mr. C. Lim	Graduate Research Assistant	0.3
Mr. V. E. Mezainis	Graduate Research Assistant	3.7
Mr. P. W. Perschbacher	Graduate Research Assistant	3.0
Mr. R. P. Phelps	Graduate Research Assistant	1.0
Mr. E. H. Robinson	Graduate Research Assistant	1.0
Mr. C. S. Tucker	Graduate Research Assistant	1.0
Mr. J. L. Williamson	Graduate Research Assistant	3.1

Part D. Fringe Benefits.

Total fringe benefits = $11,955.81[2/]

Part E. Consultants.

None

Part F. Guest lecturers[3/]

Name	Amount[4/]
Mr. Randy Hagood	$110.74
Dr. Marcel Huet	387.54
Dr. Fred Lee	209.69
Dr. S. W. Ling	246.47

1/ All Graduate Research Assistants are generally expected to spend 1/3 time on activities related to their stipend and under normal circumstances do not contribute more than 4.0 man-months to a project in a year.

2/ Fringe benefits are not paid on student labor and graduate research assistants.

3/ Additional information on guest lectures is presented on page 11.

4/ Only travel costs were charged to Grant.

Table 14. (Continued)

Part G. Travel

Type and Number		Amount
Domestic	22	6,379.48
Foreign	8	5,749.04
	30	$12,128.52

Part H. Equipment.

No items were purchased with a value in excess of $2,500.

Part I. Library aquisitions.

Books	87
Periodicals	55
Total Cost	$2,715.85

Part J. Other

For an itemized list of "Other" expenditures see Appendix IV

Appendix I List of publications Resulting from Activities of Grant-Funded Staff

D. D. Moss

Moss, D. D. 1974. Design and plan for an aquaculture research center in Colombia. 43 pp.

Moss, D. D. 1974. Recommendations concerning the development of an aquaculture research center in Colombia.

Moss, D. D. and R. O. Smitherman. 1974. Evaluation of proposed shrimp culture project in Guapi, Cauca, Colombia. 8 pp.

Moss, D. D., M. C. Johnson and W. D. Davies. 1975. Summary of survey trip to Colombia. 7 pp.

Moss, D. D., R. O. Smitherman and E. L. Diaz. 1974. Observation on the biology of Macrobrachium american Bate from a pond environment in Panama. Proceedings of the Fifth Annual Workshop of the World Mariculture Society: 29-40.

R. Allison

Allison, R., C. D. Busch and J. L. Koon. 1975. Aerating catfish ponds for increased production. Progressive Farmer, April, 1975.

Allison, R., C. D. Busch and J. L. Koon. 1975. Aeration, water quality and catfish production. Trans. ASAE, Vol. 17. No. 3:433-435.

Allison, R., C. D. Busch and J. L. Koon. 1975. Paddlewheels for catfish pond aeration. Highlights of Agriculture Vol. 22, No. 2:3.

R. T. Lovell

Lovell, R. T. 1974. Nutritional deficiencies in intensively-cultured catfish. In The pathology of fishes, ed. Ribelin, W. E. and G. Migaki. The Univ. of Wisc. Press, Madison. 1004 pp.

Lovell, R. T. and G. R. Ammerman. 1974. Processing farm-raised catfish. Southern Coop. Series Bull. 193 (Avail. from Auburn Agric. Ext. Sta.). 59 pp.

Lovell, R. T. 1974 Effects of diet fiber content on fish growth, nutrient digestibility, and water quality in practical catfish culture. Proc. Third Fish Nutrition Workshop, III: 47:14-23 Tunnison Fish Laboratory and Cornell University, Cortland N.Y., September, 1974.

Lovell, R. T. 1974. Factors affecting opimum protein level in feeds for pond grown channel catfish. Proc. Third Fish Nutrition Workshop III: 82:54-62 Tunnison Fish Nutrition Laboratory and Cornell University, Cortland, N. Y. September, 1974.

Snow, J. R. and R. T. Lovell. 1974. Comparison of organoleptic quality of largemouth bass fed natural and artificial diets. Prog. Fish. Cult. 36(4): 217.

Lovell, R. T. 1974. How much protein in feeds for channel catfish? The Comm. Fish Farmer and World Aquaculture. 1(4): 40.

Lovell, R. T. 1974. Cool weather feeding of channel catfish. The Comm. Fish Farmer and World Aquaculture. 1(5):28.

Lovell, R. T., R. O. Smitherman and E. W. Shell. 1974. Progress and Prospects in fish farming. In New protein foods, ed. Altschul, A. M. and H. Wilcke. Academic Press, Inc., New York and London. In Press

Prather, E. E. and R. T. Lovell. 1974. Response of intensively fed channel catfish to diets containing various protein-energy ratios. Proc. 27th Ann. Conf. Southeast. Assoc. Game and Fish Comrs. 27:455.

E. W. McCoy

McCoy, E. W., R. T. Lovell and G. R. Ammerman. 1974. "Processing Economics", Processing Farm-Raised Catfish. Southern Cooperative Series Bulletin 193:21-31.

McCoy, E. W. and K. W. Crawford. 1974. Costs of Overwintering Catfish Highlights of Agricultural Research. Alabama Agri. Exp. Station Vol. 21, No. 4:14.

McCoy, E. W. and K. W. Crawford. 1975. Alabama Catfish Producers, Fingerling Producers and Catfish Processors, 1974, a directory. Processed Series Dept. of Agri. Econ. and Rur. Soc. Ala. Exp. Sta. Auburn, Ala. 173 pp.

McCoy, E. W. and K. W. Crawford. 1975. Catfish are not the only fish in the pond, Highlights of Agricultural Research. Alabama Exp. Sta. Vol. 22, No. 2:10.

McCoy, E. W. 1975. "Marketing Research and Economics" Freshwater Foodfish (and crawfish), Aquatic Food Animal Task Force R. P. 407. 24 pp.

Moss, D. D., F. Cholik, Sediatmo, S. Joyodiharji, Sudibyo, E. W. McCoy, J. R. Snow and J. H. Grover. 1975. Inland and brackish water fishery expansion project in Indonesia. 51 pp.

Mario M. Pamatmat

Pamatmat, M. M. and H. R. Skjoldal. 1974. Dehydrogenase activity and adenosine triphohphate concentration of marine sediments in Lindaspollene, Norway Sarsia 56:1-12.

Pamatmat, M. M. 1974. Alkalinity, hardness, and productivity of limed ponds. J. Mar. Sci. Alabama, 2:95-110

R. O. Smitherman

Smitheman, R. O. and C. E. Boyd. 1974. Intensive management of water for fish production Chapter in book: M. C. Blount, Editor. Water Resources Utilization and Conservation in the Environment, Fort Valley State College, Fort Valley, Georgia. 451 p.

Smitherman, R. O., D. D. Moss and E. L. Diaz. 1974. Observations on the biology of Macrobrachium americanum Bate from a pond environment in Panama. Proc. of the Annual Workshop, World Mar. Society (5): 29-40.

J. R. Snow

Snow, J. R. 1974. Changes in pond bottom soils during the first ten year of use. Pro. twenty-seventh annual conf. Southeastern Assoc. of Game and Fish Comm. 27:738-744.

Snow, J. R. and R. T. Lovell. 1974. Comparison of organoleptic quality of largemouth bass fed natural and artificial diets. Prog. Fish-Cult. 36(4):216-218.

Boyd, C. E. and J. R. Snow. 1975. Fertilization of Farm Fish ponds. Leaflet 88 Ala. Agri. Expt. Sta., Auburn, AL 36830. 6 p.

Snow, J. R. In Press. Fish production in a central Alabama stock water pond. Proc. twenty-eight annual conf. Southeastern Assoc. of Game and Fish Comm. White Sulfur Springs, W. Va., 1974.

Snow, J. R. In Press. Hatchery production of the Centrarchid basses. In: A National Symposium on the Biology and Management of the Centrarchid Basses. Henry Clepper, Ed. Sport Fishing Institute Wash. D.C. 20005.

Moss, D. D., F. Cholik, Sediatmo, S. Joyodiharji, Sudibyo, E. W. McCoy, J. R. Snow and J. H. Grover. 1975. Inland and brackish water fishery expansion project in Indonesia. 51pp.

Wright, L. D. and J. R. Snow. The effect of six chemicals on largemouth bass eggs. Prog. Fish Cult. In Press.

W. D. Davies

Davies, W. D., W. L. Shelton. 1974. Potential trout production and management of lakes in Central and Southern Peru. 38pp.

Davies, W. D. and J. G. Sutinen. 1975. An evaluation of USAID Technical Assistance to EAFFRO Lake Victoria Fisheries Project. 25pp.

E. W. Scarsbrook

Boyd, C. E. and E. Scarsbrook. 1974. Effects of agricultural limestone on phytoplankton communities in ponds. Arch. Hydrobiol. 74:336-349.

Appendix II. List of Visitors Seeking Information on International Development

Toshihiko Arai, M.D. Assistant Professor Department of Microbiology School of Medicine Keio University 35 Shinanomachi, Shinjuku-ku Tokyo, Japan	July 28-31, 1974
Dr. Takashi Aoki Department of Fisheries Faculty of Agriculture University of Tokyo	July 28-31, 1974
Dr. S. Egusa, Professor Department of Fisheries Faculty of Agriculture University of Tokyo 1-1-1 Yayoi Bunkyo-ku 113 Tokyo, Japan	July 28-31, 1974
Mr. and Mrs. Conrado F. Estrella Secretary Department of Agrarian Reform Republic of the Philippines	August 5-6, 1974
John Obbo Ikaronon 802 Monroe Street Ann Arbor, Michigan 48104	August 5-31, 1974
Raul Castro Conde 5G C. #34-74 Zona M Guatemala	August 9, 1974
Luis Alfredo Alonzo Fernandez 19 Av 29-81 Zona 12 Guatemala	August 9, 1974
Adan Lopez Rios 23 Av 1073 Zona 7 Guatemala	August 9, 1974
Harris H. Whitbeck 23 Av. 0-37 Zone 15 Guatemala City, Guatemala C.A.	August 9, 1975
Michael Hoeft Box 627 Wayne, W. Va. 25570 1-304-849-3214	August 14-16, 1974

Mark Majewski
c/o WMUL-TV
3rd Avenue
Huntington, W. Va. 25701 — August 14-16, 1974

Dr. Leon Hesser
Office of Agriculture
Bueau of Technical Assistance
Agency for International Development
Washington, D.C. 20523 — August 20-21, 1974

Dr. Colin Nash
Oceanic Institute
Makapuu Point
Waimanalo, Hawaii — August 20-21, 1974

Guy Rothwell
Oceanic Institute
Makapuu Point
Waimanalo, Hawaii — August 20-21, 1974

William Sellew
Oceanic Institute
Makapuu Point
Waimanalo, Hawaii — August 20-21, 1974

Professor Marcel Huet
Avenue General Derache, 104
1050 Bruxelles
Belgium — August 26-28, 1974

Mr. Anthony A. Neylan
International Bank for Reconstruction & Development
Washington, D. C. 20433 — August 30, 1974

Paul Maugle
c/o USAID
Edifico Bavaria
Piso 17
Bogota, Colombia — Spetember 10-11, 1974

Professor Gelar Wira Atmadja
Faculty of Fisheries
Bogor Agricultural University
Bogor, Indonesia — September 15-20, 1974

James Davis
Fish Culture Extension Specialist
Texas A&M University — September 27, 1974

Noel C. Alon
E. Litton & Associate
Wack-Wack Subdivision
Mandaluying, Rizal
Claveria, Misamis Oriental, Philippines

or P. O. Box 1772 Makati Commercial Center Makata, Rizal 3117	October 14-November 4
Alicia Cornejo Black Assistant Professor Santiago, Chile	October 15-20, 1974
Ms. Terry Rockefeller WGBH TV Boston, Mass.	October 24, 1974
Dr. Salvador Lopez President of the University of the Philippines Manila, Philippines	November 13, 1974
Mr. Luis A. Rivas L Division Pesca Continental Ministerio de Agricultura y Cria Oficina Nacional de Pesca Av. Benito Juarez, Qunta Tremar Alta Florida, Caracas Venezuela	November 14-15, 1974
Randy Hagood Marine Research Lab St. Petersburg, Florida	November 15, 1974
Mr. Fred Lee, Director Institute for Environmental Sciences University of Texas Dallas, Texas	November 22, 1974
Hugo Cuevas, Jr. P. O. Box 555 W.P.I. Worchester, Mass.	November 27, 1974
Dr. Takeshi Nose Fish Nutritionist Freshwater Fisheries Research Laboratory Fisheries Agency, Ministry of Agriculture Hino, Tokyo, Japan	December 7, 1974
Dr. Frank Sheppard USAID/Philippines	December 16-17, 1974
Dr. S. W. Ling FAO Fishculturist Retired Adjunct University of Miami	January 16, 1975

Tom Niblock AID Mission Director	February 5-6, 1975
Gerald Sicat GOP Planning Commissioner	February 5-6, 1975
Dr. Ervin Long Associate Assistant Administrator Bureau of Technical Assistance Agency for International Development Washington, D.C. 20523	February 5-6, 1975
Dr. John Pino Director for Agriculture Rockefeller Foundation New York, N.Y.	February 5-6, 1975
Dr. Jerry Grant Rockefeller Foundation in Colombia	February 13, 1975
Gordon E. Hall Forestry, Fish and Wildlife Tennessee Valley Authority Norris, Tennessee	February 19, 1975
John Hall Atlanta Bureau of Sport Fisheries & Wildlife Division of Federal AID Atlanta, GA	March 17-20, 1975
John Young Michigan State University Peace Corps Intern	March 17-20, 1975
Joseph Trudeau Michigan State University Peace Corps Intern	March 17-20, 1975
Dave Smith Michigan State University Peace Corps Intern	March 17-20, 1975
Mark T. Halter Michigan State University Peace Corps Intern	March 17-20, 1975
Don Palawski Michigan State University Peace Corps Intern	March 17-20, 1975
Linda Parker Michigan State University Peace Corps Intern	March 17-20, 1975

John E. Spielby
Michigan State University
Peace Corps Intern — March 17-20, 1975

Cary Kerns
Michigan State University
Peace Corps Intern — March 17-20, 1975

Howard E. Johnson
Michigan State University
Peace Corps Intern — March 17-20, 1975

John J. Castle
Michigan State University
Peace Corps Intern — March 17-20, 1975

Mr. Gander
New Zealand — April 24, 1975

Wen-Ted Chang
Taiwan Fisheries Bureau
8 Sec. 1, Chan-Hsiao East Rd.
Taipei, Taiwan 200
Republic of China — April 28-29, 1975

F. Brian Davy
Programme Officer
308-314 Duke Hall
University of British Columbia
Vancouver, B.C. V6T IW5, Canada — April 28-29, 1975

Mr. Philip Roedel
USAID/Washington
Office of Agriculture
Bureau of Technical Assistance
Washington, D.C. 20523 — April 30-May 1, 1975

Kadar Dia
Fullbright Scholar Student
Ivory Coast — May 10, 1975

George Umeh
Student from Nigeria
University of Wisconsin
Madison, Wisconsin — May 19, 1975

Dr. Dwight Steen
Rural Development Officer
American Embassy (USAID)
APO New York 09895
Colombia — May 19, 1975

U Than Sein, BA
Inspector of Schools
Department of Technical Ag & Vocational Ed
Rangoon Burma — June 16-17, 1975

U Nyunt Shein
Principal
Tech High School
Rangoon Burma — June 16-17, 1975

Ducksoo Lee
Senior Economist
East Asia Projects Dept.
International Bank for Reconstruction & Development
18118 H. Street N. W.
Washington, D.C. — June 17, 1975

Dr. Sam Myers
Department of Food Science
Louisiana State University
Baton Rouge, LA — July 10, 1975

George Wm. Kissil
Israel Oceanographic and Limnological Research Ltd.
Mariculture Laboratory
P. O. Box 1212
Eilot Israel — July 10, 1975

Appendix III Itemized List of Travel on Grant Funds

DATE	STAFF	COUNTRY	COST
5/31-6/9/74	John H. Grover R. O. Smitherman	Israel	$2,116.06
(To attend International Symposium on Mullets and Their Culture)			
6/17-6/29/74	E. E. Prather	Jamaica	617.76
(To survey aquaculture potential)			
6/23-6/29/74	M. M. Pamatmat	Seattle, Wash.	547.30
(To present a paper at the annual meeting of American Society of Limnology and Oceanography)			
7/7-7/9/74	E. W. Shell D. D. Moss E. W. McCoy	Washington, D.C.	629.92
(To confer with USAID officials)			
7/9-7/14/74	David Hughes	Stillwater, Okla.	272.49
(Consult with John Jensen (Fish Culture Extension Specialist-Brazil project) and Director of International Center for Aquaculture)			
7/24-7/25/74	D. D. Moss E. W. McCoy R. O. Smitherman	Tallahassee, Fla.	281.06
(To discuss Aquaculture Economics Proposal for USAID)			
8/5-8/6/75	M. M. Pamatmat	Mobile, Ala.	30.00
(To make a presentation of research proposal to the Bureau of Land Management)			
8/25-8/29/74	Marcel Huet	Auburn, Ala.	387.54
(Reimbursement for travel to Auburn from Winnipeg, Canada and return to consult with staff of International Center and present seminars to staff and students)			
8/25-8/30/74	David G. Hughes	Arkansas and Mississippi	293.61
(Tour of warmwater fish culture, processing and research facilities)			
9/4-9/6/74	E. W. McCoy	Kingston, R.I.	238.44
(To review University of Rhode Island resource economics as representative of the International Center for Aquaculture)			
9/7-9/12/74	R. O. Smitherman	Hawaii	666.02
(To attend American Fisheries Society Meeting and visit to Macrobrachium farms)			

DATE	STAFF	COUNTRY	COST
9/17/74	Jerald Lee Williamson Roger Yant	Tupelo, Miss.	$ 19.50
(To purchase fish feed)			
9/23-9/26/74	R. T. Lovell	Cortland, N.Y.	247.55
(To attend Fish Nutrition Workshop and present two reports)			
9/23-9/29/74	M. M. Pamatmat	Bordeaux, France	96.63
(To give lecture at the International Meeting of Meiofauna Physiological Ecology)			
9/29/74	R. O. Smitherman	Colombia	328.03
(Advance per diem for travel to Colombia to assist USAID and Government)			
10/4-10/8/74	D. D. Moss	St. Louis, Mo.	175.91
(To participate in the Fish Culture Section Executive Meeting of American Fisheries Society)			
11/14-11/15/74	Randolf W. Hagood	Auburn, Ala.	110.74
(Reimbursement of travel to Auburn, Ala. from Florida State Department of Natural Resources in St. Petersburg, Fla. to present seminar)			
11/16-11/17/74	David Dunseth	Miami, Fla.	174.22
(To receive live fish being shipped from Brazil Aquaculture Project)			
11/21-11/22/74	D. Fred Lee	Auburn, Ala.	209.69
(Reimbursement of travel to Auburn, Ala. from University of Texas at Dallas to present seminar)			
11/23-12/10/74	David G. Hughes	Uruguay and Brazil	776.70
(To participate in FAO sponsored Aquaculture Conference to be held in Montevideo, Uruguay and to visit Aquaculture Research Project in Fortaleza, Brazil)			
12/1-12/6/74	Jack Snow	London, England	1,163.50
(Conference on Fish Farming in Europe).			
1/5-1/22/75	D. D. Moss	Colombia Panama Costa Rica	112.40
(To consult with USAID Colombia on Fish Culture Project (Paid by USAID/Wash.). To Panama to consult with USAID Panama. To Costa Rica to participate in Fisheries Workshop - invited by and (Paid for by Univ. of R.I.).)			
1/16-1/22/75	S. W. Ling	Auburn, Ala.	246.47
(Travel from Miami, Fla. to Auburn, Ala. to present a Departmental Seminar and be available for consultation by students and staff)			

DATE	STAFF	COUNTRY	COST
1/26-1/30/75	D. D. Moss	Seattle, Wash.	$ 514.22
(To attend World Mariculture Society Meeting)			
3/6-3/7/75	D. D. Moss	Washington, D.C.	177.80
(To confer with USAID officials)			
3/16-3/21/75	Malcolm C. Johnson	Bogota, Colombia	537.96
(To assist USAID and Government of Colombia develop plans for lake Management and Aquaculture research station)			
3/23-3/24/75	D. D. Moss	Baton Rouge, La.	134.60
(To attend Board of Directors Meeting of World Mariculture Society)			
4/23-4/24/75	E. W. Shell D. D. Moss	Washington, D.C.	359.30
(To confer with USAID Officials)			
5/12-5/16/75	E. W. Shell	Honolulu, Hawaii	609.35
(Meeting with USAID sponsored water resources management group)			
5/20-5/21/75	D. D. Moss	Yazoo City, Miss.	53.75
(To accompany official visitor of Fisheries Dept. to visit commerical fish farmers in Mississippi)			
			$12,128.52

Appendix IV Itemization of "Supplies, Library, and Other" Category from Table 14

Items	Amount
Hourly field and student labor	12,543.26
Library	2,715.85
Expendable research and office supplies	9,560.23
Telephone and telegraph	2,450.50
Freight and express charges	146.65
Electricity	599.23
Vehicle maintenance and operations	981.16
Postage	815.36
Printing and binding	1,278.48
Fees for courses attended by senior staff	30.00
Repairs to research and office equipment	267.35
Equipment rental	4,050.58
Services required in support of grant activities	1,144.10
	36,582.75

Appendix V. Summary of results of research conducted by Grant staff

A. Aquaculture

Concrete ponds (0.005A) stocked with Tilapia aurea were evaluated in terms of productivity and maintenance of water quality. All ponds were maintained for 107 feeding days. (Conversion ratios (pounds of feed/pounds of fish gain) varied from 0.9:1 to 1.7:1. Net gains in excess of 17,000 lb/acre were achieved. Ponds stocked with 400 fish produced an average net gain of 77.2 lbs/pond; 200 fish fed pelleted feed produced an average net gain of 54.2 lbs; 200 fish fed non-pelleted feed produced an average of 47.2 lbs; 100 fish with pelleted feed produced an average of 44.5 lbs (Allison and Smitherman).

Striped bass fry were cultured in twelve, 7.6-l hatching jars and twelve 38-l aquaria set up on recirculating water systems. Effects of diet, salinity, and container shape and size on survival and growth were tested. Data obtained from daily mortality counts and weekly growth samples showed that no significant differences in survival resulted between tests involving container shapes or levels of salinity. Fry survived and grew significantly better ($P = .01$) on the brine shrimp diet than on the dry feed diet. Growth of fry was significantly better ($P = .01$) in aquaria than in jars. There was no difference in growth rates of fry cultured in the two salinity levels (Shell).

Light attraction experiments involving the effects of wave length and intensity of light on striped bass fry behavior were conducted at night using fry in the first and third experiments. Using a high intensity lamp, colored filters, and a voltage regulator, it was determined that fry were attracted to light of moderate intensities. Light of low

intensity was not powerful enough to attract fry, while fry appeared to avoid intense light. No difference was observed in behavior of fry to light of various wave lengths (Shell).

An experiment was conducted from October to December, 1974 to determine if clomiphene citrate would induce gonadal development in channel catfish. Feed containing the chemical was fed to males and females in separate ponds. Five females were sacrificed at 2-week intervals and the Gonadal Somatic Index determined for each. Males were sacrificed only at the end of the experiment. Control fish were treated in the same manner. There was no difference in gonadal development of the fish fed the chemical and control fish (Busch).

Disc gel electrophoresis of serum proteins of Tilapia aurea was used to determine if any sex-related differences existed in the electroherograms. Analysis of the number of bands, frequency, and position of these bands will be continued with greater numbers of fish in the hope that differentiation of males and females will be possible (Smitherman and Hardin).

A polyculture experiment with channel catfish (3000 per acre) as the principal species in the system and various stocking combinations with tilapia, hybrid buffalo and Israeli carp was conducted from March to October 1974, in 22, 0.1-acre earthen ponds. In addition to yields, temperature, oxygen and water hardness data were recorded periodically. All ponds were limed, and food was kept constant in all treatments. Results indicated no effective competition of tilapia with channel catfish at the lower stocking rate of tilapia (250 per acre), and tilapia represented an extra 200 lbs. of harvestable size fish an acre. The larger size tilapia fed on the pel-

lets but the channel catfish preyed upon the tilapia reproduction. Hybrid buffalo stocked both at 100 adults per acre or 1000 fingerlings per acre decreased channel catfish yields, as did Israeli carp stocked at both 40 or 100 per acre (Smitherman and Pretto).

Fry (9-11 mm) of Tilapia aurea were orally administered androgen (Ethenyltestaterone) or estrogen (Estrone). The fish were then reared in concrete tanks and earthen ponds. Sex ratio and growth rate were determined. Fish treated with androgen were 93 to 100 percent male, but estrogen-treated fish had essentially normal sex ratios. Growth of hormone-treated fish from May to October, 1974,was similar to that of control fish (Shelton).

Food habits of channel catfish, adult and fingerling hybrid buffalofish, Tilapia aurea, and Israeli carp were studied in polyculture. Studies were conducted on the stomach contents of these fishes in May, July, and October. Supplemental feed was the primary food of the channel catfish in polyculture, and it became increasingly more important to the tilapia, hybrid buffalofish, and Israeli carp as the total weight of fish in the ponds increased. In October, tilapia remains were found only in one percent of the channel catfish. This low percentage was believed to be the result of low water temperatures (Smitherman and Yant).

Three treatments in the R-Pond series each replicated three times were evaluated in terms of productivity, maintenance of water quality and power requirements. Productivity varied from 4,998 lb/acre to 4,789 lb/acre and conversion ratios (pounds of feed/pound of fish gain were similar in all ponds, 1.4:1. Average percentage of harvestable fish per pond varied from 65.5% to 69.6%. Maximum feed per acre was in excess of 2,300 lb. During the last 59 days of the experiment an average of 59 lb/acre/day was fed. Dissolved oxygen

profiles and flow patterns showed some differences with depth and type of aerating device. Power consumption approached a cost comparable with other production costs, ranging from $0.03 to $0.07 per pound of fish produced (Allison).

A comparison of the production of channel catfish and a hybrid (blue X channel) catfish was made in earthen ponds. The fish were compared for survival, food conversion, growth, size uniformity, dress-out percentage, and chemical compositon. Significant differences existed between the two fishes, with the hybrid being superior in all phases except for a greater fat content(Smitherman).

B. Fish Nutrition

Although catfish can absorb adequate clacium from the water, they must have dietary phosphorus for optimum growth rate in ponds. All-plant diets containing 0.69% total P, or 0.22% available P, did not allow for maximum growth by channel catfish in earthen ponds; however, when 0.3% phosphorus from Ca H PO_4 was added to the all-plant diet, to bring the available P level up to 0.52%, maximum growth rate by the channel catfish was obtained. Higher supplemental levels of P did not result in improved growth (Lovell and Prather).

Vitamin C (ascorbic acid) was previously demonstrated to be essential in the diet for channel catfish grown in cages or artificial environments. During 1972-1974 feeding studies were conducted to determine the necessity of vitamin C in pond feeds for channel catfish stocked at 2,000 to 10,000 per acre. Vitamin C was not necessary in practical feeds when fish were stocked up to 4,000 per acre (yield of 3,700 lb/acre) as indicated by no differences in growth incidences of deformed spinal columns, hemorrhagic tissues, alkaline phosphatase activity, blood or kidney levels of ascorbic acid, or susceptibility to bacterial infections between catfish fed vitamin

C in the feed and those fed no vitamin C. However, when stocking density was increased to 10,000 per acre (in pens along the edge of the large ponds) poorer growth, deformed backs and higher mortalities due to bacterial infection were found in fish not receiving vitamin C in the feed (Lovell).

When ethylcellulose coated ascorbic acid was used in pelleted fish feeds, an average of 84% of the vitamin activity remained following the pelleting process; however, following extrusion, an average of 66.5% of the activity remained. With non-coated ascorbic acid, 49% of the activity remained following pelleting; however, 0% remained after extrusion. After 4 months storage at ambient temperature, 23.9% of the vitamin was recovered from the pelleted feeds and 21.7% was recovered from the extruded feed (Lovell).

Floating and sinking forms of Auburn no. 4 catfish feed formula were fed to channel catfish, stocked at 3,000 per acre, for 200 days in 3.5 (floating feed) and 12.5 (sinking feed) acre ponds. Feeding rates were similar to those previously used in 1/10-acre ponds when fish fed this feed in pellet form gained 0.98 lb (2,950 lb/acre). Average gain by the fish fed the floating feed in the large pond was 0.77 lb. Gain by fish fed the sinking feed in the large pond, estimated by seine sampling was 0.72 lb, or 93.6% of that by the fish fed the floating pellets(Prather and Lovell).

Pound-size channel catfish, which had previously been fed intensively for 6 months, were weighed and measured and placed back into nine 1/10-acre earthen ponds at the rate of 2,000 per acre. The fish were managed through the winter until the following March 4 on one of three feeding regimes; no feeding; feeding 1% of fish weight on alternate days; and feeding 1% of fish weight only on "warm" days or when water tempera-

ture at a 3-foot depth was above 54 F. Fish not fed lost 9% of their weight during the 100-day over-winter period, those fed on alternate days received feed on 51 days and gained 19%. Condition factors increased for both groups of fed fish but decreased for the non-fed fish. Length increased slightly for all groups. Although the nonfed fish lost weight, they had the highest percentage of body fat indicating that a significant amount of tissue protein was degraded for energy needs. The protein content of the fed fish was higher and the fat content was lower than that usually found in summer-fed fish (Lovell).

C. Aquatic Ecology

Benthic community metabolism was studied in two earthen ponds to better understand the problem of organic decomposition and consequent depletion of dissolved oxygen in bottom water. These ponds were densely stocked with channel catfish. The role of the bottom mud and its associated biotic community in the consumption of oxygen needs to be clarified in order to better evaluate different ways of alleviating low oxygen conditions in bottom water. The bottom water below a depth of 6 ft in one of the ponds became anoxic as early as June. The benthic community may have been supplied with a small amount of oxygen through mixing of bottom water with overlying water but this has not been assessed. In any case, metabolic activity of benthos in ponds with anoxic bottom water during the fish-growing season must be measured by methods dealing with anaerobic metabolism (Pamatmat).

D. Fish Pathology

Channel catfish populations were immunized against Ichthyophthirius by exposure to controlled numbers of the parasite and by injections with ground trophozoites. Exposed and injected fish were challenged with 20 trophozoites per fish. Mortality in controls, 20 trophozoites exposure, 40 trophozoites exposure and ground trophozoites was 100, 6.6, 0 and 0

percent respectively (Allison).

E. Processing and Marketing

Buffalo fish and tilapia, which were grown in combination with channel catfish in polycultures, were mechanically deboned along with channel catfish on a Bibun bone separating machine. A 7-mm diameter hole in the extrusion cylinder of the machine was satisfactory for separating the flesh from the bone of all three fish species. No significant amounts of bone or scales were left in the flesh and particle size of the minced flesh was relatively large which allowed for favorable texture when cooked. Scaling prior to deboning was not necessary. Importance for high quality minced flesh were processing soon after the fish died, prewashing with chlorine solution, removal of black peritoneium in tilapia, and removal of skin pigment with a hot alkali on catfish prior to deboning. Yields, expressed as percentage of whole fish were 50.5 for buffalo fish, 39.7 for tilapia and 43.7 for channel catfish. All species were highly acceptable in various consumer-type products when evaluated by a taste panel (Lovell).

During the last three years, a comprehensive chemical evaluation of the nutritional composition of farm-raised catfish was made. These data are presented in tabular form following the format used in U.S.D.A. Handbook No. 8 "Composition of Foods". The tables include protein, fat, energy, water, ash, Ca, P, Fe, Na, K, vitamin A, riboflavin, niacin, thiamine, cholesterol, amino acids, and fatty acids. All nutrients required by F.D.A. for nutritional labeling for consumer foods are provided (Lovell).

Technology was developed for making a flaked aquarium fish feed, containing fish processing waste, that floated and was stable in water, was palatable to several species of aquarium fishes, was nutritionally adequate for growth and produced pigmentation in ornamental aquarium fish. The following formula was equal to an expensive commercial flaked fish feed in all

aspects: catfish waste (or marine fish) meal, 15%, shrimp meal, 15%; dehulled soybean meal, 45%; rice polishings (or wheat bran), 9%; wheat bran, 7%; marine fish oil, 4%; marigold petal meal, 0.113% and a complete vitamin supplement (Lovell).