

AGENCY FOR INTERNATIONAL DEVELOPMENT WASHINGTON, D. C. 20523 BIBLIOGRAPHIC INPUT SHEET	FOR AID USE ONLY Batch #22
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1. SUBJECT CLASSIFICATION	A. PRIMARY Agriculture	AM00-0000-G514
	B. SECONDARY Fisheries--Brazil	

2. TITLE AND SUBTITLE
 Progress report II on the Brazil aquaculture project

3. AUTHOR(S)
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4. DOCUMENT DATE 1973	5. NUMBER OF PAGES 17p.	6. ARC NUMBER ARC
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7. REFERENCE ORGANIZATION NAME AND ADDRESS
 Auburn

8. SUPPLEMENTARY NOTES (Sponsoring Organization, Publishers, Availability)

9. ABSTRACT

10. CONTROL NUMBER PN-RAB-351	11. PRICE OF DOCUMENT
12. DESCRIPTORS Brazil	13. PROJECT NUMBER
	14. CONTRACT NUMBER CSD-2270 GTS
	15. TYPE OF DOCUMENT

**Progress Report II
on the
Brazil Aquaculture Project**

**Submitted
by**

**Leonard L. Lovshin
Project Leader**

**USAID - Auburn University
Task Order No. 8
Contract AID/csd-2270**

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INTRODUCTION

This is the second semi-annual report concerning the activities of the Auburn University Contract, Task Order No. 8, Contract AID/csd-2270.

Project objectives, status of project upon arrival and progress in the first six months of the contract can be found in the first semi-annual report submitted by the author on December 16, 1972. This report will deal with the authors activities within the Convenio, DPAN, during the period December 16, 1972 through June 30, 1973.

Progress in the Second Quarter of the Contract

The author has been pleased with the cooperation and progress shown by fisheries personnel within the DNOCS organization this past six months. Perhaps the single most important accomplishment in the project's six year history was implemented in February when DNOCS created a separate Department or Directoria of Fisheries within DNOCS. Formerly, the Division of Fisheries was under the control of the Directoria of Agriculture and Irrigation. Under these conditions, top level decisions concerning fisheries were made by men with little knowledge or understanding of fisheries so that administrative

procedures were often slow and irrational. Now that the Division of Fisheries is a separate Directoria, leadership is provided by Dr. Adhemar Braga who has worked in the field of fisheries within DNOCS for many years and has a firm understanding of fisheries work and the problems that face DNOCS to improve their fisheries programs in the future.

With the establishment of the Directoria of Fisheries, the entire DNOCS fisheries structure has been reorganized to better utilize existing facilities and personnel. While still in a period of adjustment, the overall improvement in communication, cooperation and departmental spirit is noticeably recognizable. New ideas, research programs and training programs are being developed, initiated and carried out at such a rate that the major problem facing the Directoria of Fisheries in the future is providing enough trained personnel to carry out the programs. As word of the activities, capabilities and facilities of the Directoria's scientists, fish hatcheries and research stations is being spread throughout Brazil and South America, the requests for technical help, training and information from government agencies within Brazil as well as from neighboring countries and from private individuals is placing a high demand on fisheries staff.

The increased interest in research activities and demand for assistance from within DNOCS, outside organizations and private individuals is beginning to show in the increased pride and confidence that Convenio DPAN personnel are showing in their work and organization. This new pride and confidence is beginning to be translated into an improved research effort resulting in productive and meaningful outputs. The author feels a great step forward has been made by DNOCS and that the establishment of the Directoria of

Fisheries lays the administrative foundation for progressive improvements throughout the DNOCS fisheries organization.

The following are the major accomplishments of the past six months.

1) Construction--Two, 0.3 ha, earthen ponds have been completed and are being used in experimental work. Also completed are 10, 30 m², concrete sided tanks to be used in fish spawning, raising of larval fishes and shrimps and for experimental purposes. The tanks are 12 m long, 2.5 m wide and 1 meter deep with earthen bottoms and reinforced, vertical concrete sides. The tanks are provided with a cement catch basin and separate inlets and drains. The tanks can be filled and drained in less than one hour and provide a highly controlable and versatile experimental unit. The Penecoste Station now contains 56 earthen ponds and 10 concrete tanks with an area of approximately 6 hectares in water.

Major construction will now be centered on the 100 ha of land owned by DNOCS located below the Pentecoste Reservoir Dam. Construction has been started on 7, 400 m², earthen ponds and related water inlets and drains. Plans call for the construction of 41 more 0.04 ha and 8, 0.5 ha earthen ponds within the next six months.

2) Research--The author is particularly pleased with the progress made at the Pentecoste Research Station in the last six months. DNOCS biologists working at the research station are gaining understanding and confidence in their research methods and ability to properly manage a research station. Understanding and confidence in research and station management should result in an efficient flow of quality, experimental results without undue delays.

The following are summaries of results to date; at the termination of each experiment a more detailed report of the results for each experiment will be submitted.

Hybrid Tilapia--The results of our first experimental work with Hybrid Tilapia can be found in Table 1. The hybrids are produced by crossing male Tilapia hornorum with female Tilapia nilotica to produce 100% male offspring. The experiment was carried out in 18, 0.04 ha earthen ponds using a factorial design, three treatments, each replicated three times at two different levels of stocking. All ponds within a treatment were treated equally. Ponds fertilized with organic manure were fertilized once a week with 30 kg (750 kg/ha) of cattle manure. Ponds involving feeding were fed 6 days a week with a ration composed of 50% wheat chafe and 50% castor bean meal. The ration was mixed with water, formed into a moist feed ball and placed into feeding trays located in the ponds. Ponds with the same level of stocking were fed equally, receiving 3% of the average standing crop calculated for the three ponds within that treatment. Fish were fed $\frac{1}{2}$ of the daily allotment in the early morning and the remaining portion in the late afternoon. Feeding rates were recalculated each month with the aid of a monthly seine sample.

While the author has not yet analyzed the data statistically and, thus, can not make any conclusions about the experimental treatment, there is little doubt that the Hybrid Tilapia can be feasibly cultured. The author feels that higher stocking rates coupled with higher levels of fertility and fish survival will produce even higher productions in the future.

In order to evaluate consumer acceptance and market prices of the hybrid,

Table 1
Summary of Results of Male Hybrid Tilapia Experiment

STOCKING LEVELS TREATMENTS ¹	5,000/ha			8,000/ha		
	CONTROL	ORGANIC FERTILIZER	FEED	CONTROL	ORGANIC FERTILIZER	FEED
Total Production kg/pond ²	11.8	28.7	35.0	9.9	36.3	63.5
Total Production kg/ha	295	718	875	248	920	1,586
Net Production kg/pond	10.3	27.3	33.6	6.4	33.1	60.0
Net Production kg/ha	258	683	840	160	827	1,500
Ave. weight of fish at stocking, g	7.4	7.4	7.1	8.0	7.3	7.2
Ave. Weight of fish at harvest, g	58	166	185	36	143	229
Percent Survival	83.3	86.5	94.0	87.3	90.1	86.4
Fertilizer Applied kg/pond	--	990	--	--	990	--
Fertilizer Applied kg/ha	--	24,750	--	--	24,750	--
Feed Fed kg/pond	--	--	91.3	--	--	163.5
Feed Fed kg/ha	--	--	2,283	--	--	4,088
Feed Conversion	--	--	2.7:1	--	--	2.7:1
Days of Experiment	253	253	253	253	253	253

¹Each treatment is the average of three replicates.

²Pond = 400 m²

arrangements were made to sell fish in three public markets in Fortaleza and one market in Pentecoste. Fish were transported to Fortaleza in containers without water and after a two-hour period out of water, arrived in Fortaleza alive. The results of the sale and rough calculations dealing with the economy of culturing hybrid Tilapia are found in Table II. Estimates were calculated using the market price of 3 cruzeiros/kg although some fish were sold for as high as 4 cruzeiros/kg. Each fish dealer was given 30 kg of fish ranging in size from 189 g to 250 g. In Fortaleza, two days were needed to sell all the fish. A majority of the fish were sold the second day when the price of 3 cruzeiros/kg was more acceptable to the consumer than the opening day price of 4 cruzeiros for live fish. However, in the interior town of Pentecoste where freshwater fish are common and readily accepted by the people, 30 kg of fish were sold within four hours of the first day at 3 cruzeiros a kg. Much work remains to be done in the marketing of this fish. Major problems to be resolved in the Fortaleza area are acceptance of a freshwater fish in an area dominated by saltwater fish and the size of the fish preferred by the consumer. However, there appears to be little doubt that hybrid Tilapia can be raised economically using cheap, agricultural by-products for feeds.

To further test the culture potential of the hybrid Tilapia, a new experiment is now in progress utilizing three treatments, replicated twice, at one level of stocking. In an effort to increase pond fertilities and, thus, increase growth rates and production, increased levels of fertilizing along with a combination of fertilizing and feeding are being tested. Fish stocked at 8,000/ha are being tested under conditions of organic manure applied at 1,250 kg/ha/week, inorganic fertilizer applied at 100 kg/ha approximately every two weeks and a

Table II

Partial Economic Summary of the Intensive Culture
of Hybrid Tilapia Stocked at 8,000/ha and Raised
Under Experimental Conditions

TREATMENT	FEEDING	ORGANIC FERTILIZER
Feed - kg/pond	163.5	--
Feed - kg/ha	4,088	--
Cost of Feed/kg ¹	(\$0.043) 27 centavos	--
Cost of Feed/ha	(\$184.00) 1,104 cruzeiros	--
Fertilizer Applied - kg/pond	--	990
Fertilizer Applied - kg/ha	--	24,750
Cost of Fertilizer	--	Considered free or at very low cost to farmer
Market Price of Fish/kg	(\$0.50) 3 cruzeiros	(\$0.50) 3 cruzeiros
Total Fish Production - kg/ha ²	1,586	920
Profits From Sale of Fish	(\$792.00) 4,758 cruzeiros	(\$460.00) 2,760 cruzeiros
Total Profits/ha ³	(\$608.00) 3,646 cruzeiros	(\$460.00) 2,760 cruzeiros

¹ 6 cruzeiros = 600 centavos = \$1.00

² Average of three replicates

³ Not including cost of materials, construction costs, labor or transport

combination of organic manure applied at 1,250 kg/ha/week and feeding. This experiment should lead to a better understanding of the true culture potential of the hybrid Tilapia.

The results of these experiments and future work with the hybrid Tilapia should lead to extensive culture of the fish by DNOCS in its irrigation projects and by private farmers interested in raising fish.

Culture of Tilapia nilotica with Pescada do Piaui (Plagioscion squamosissimus)--
In an effort to control reproduction in Tilapia nilotica cultures, an experiment is in progress to test the effectiveness of the predator species, Pescada do Piaui, in mixed culture with T. nilotica. Pescada is a known predator that is very common in the reservoirs of the Northeast of Brazil and spawns naturally in ponds. Because of its availability, it is a natural predator species to be raised with T. nilotica to control unwanted offspring so common in Tilapia cultures. Two earthen ponds have been stocked with T. nilotica at the rate of 5,000/ha and are being fertilized with organic manure and fed a simple ration. Two other earthen ponds have been stocked with T. nilotica at 5,000/ha but have Pescada do Piaui stocked at the rate of 1,000/ha. These two ponds are also being fertilized with organic manure and are being fed. At this date, Pescada appears to be controlling Tilapia reproduction but final confirmation will have to wait for the termination of the experiment when ponds can be drained and fish counted.

Culture of Tilapia nilotica in combination with pigs--An experiment is now in progress testing the economic feasibility of raising pigs in conjunction with the culture of Tilapia nilotica. Two, 0.3 ha, earthen ponds are being

used in this experiment. One of the ponds has been stocked with T. nilotica at 10,000/ha and is being fertilized with cow manure at the rate of 750/kg/ha/week. The second pond has also been stocked with 10,000 T. nilotica/ha but has a pig sty built on its margin. The sty is 36 m² with a stone and cement foundation wood enclosure, and palm frawn roof. The sty holds 22 pigs which are fed daily on a ration of agricultural by-products, grass, and meat meal. The pigs are allowed access to the pond in a small enclosed area. Feces and waste feeds are washed into the pond daily. DNOCS biologists are interested in providing a demonstration for farmers as well as gaining some insight into the economic feasibility and problems of raising fish in conjunction with pigs.

Tambaqui (Myletes bidens)--A single pond experiment testing the production, growth, durability of this fish to adverse environmental conditions and handling, and the efficiency of the fish in utilizing pelleted feeds has been terminated. The author feels that Tambaqui demonstrated excellent cultural potential.

A detailed report covering the results of this experiment can be found in the appendix to this report.

The author and DNOCS personnel had high hopes that the Tambaqui could be spawned during the 1973 rainy season but lack of mature broodstock prevented attempts. Three year old Tambaquis with an average weight of about 6 kg are available for spawning but no fish with well prepared gonads have been encountered up to this date. However, for the first time, small quantities of sperm have been obtained from several males. The author still has high hopes that Tambaqui can be spawned in the future when ripe fish become available.

Pirapitinga (Mylossoma sp.)--A single pond experiment testing the rate of growth, production, durability to adverse environmental conditions and handling, and the efficiency of the fish in utilizing pelleted feeds has also been terminated. Pirapitinga also shows exceptional potential as a culture fish. A detailed report covering the results of this experiment can be found in the appendix to this report.

Pentecoste research station biologists had hoped to spawn Pirapitinga this past spring. As with Tambaqui, no mature Pirapitinga were encountered and attempts to spawn the 3 year old broodstock found on the station will have to wait until ripe fish are available.

Israeli Carp (Cyprinus carpio)--The following table is a summary of an experiment conducted in a 0.04 earthen pond. Fish were stocked at the rate of 1,925/ha and fed a pelleted ration containing 29.1% protein at a rate of 3% of the standing crop of fish in the pond per day, 6 days a week. The feeding rate was changed every month with the aid of a seine sample. Maximum feeding rate per day was 872 g. The experiment was terminated after 190 days.

Weight at harvest	34.0 kg (850 kg/ha)
Weight at stocking	14.0 kg (350 kg/ha)
Net Production	20.0 kg (500 kg/ha)
Ave. weight of fish at stocking	183 g
Ave. weight of fish at harvest	441 g
Weight of ration fed	100.6 kg
Conversion of ration	5.0:1
Survival	100%

The author does not consider the net production of 500 kg/ha of Israeli Carp in 190 days exceptional using a pelleted ration. As this preliminary experiment was carried out in somewhat less than ideal experimental

conditions, conclusions regarding the culture potential of this strain of carp will have to await more thorough testing.

The Israeli Carp has been spawned several times at the Pentecoste Research Station both naturally and with hormones. A supply of fingerlings is now available for experimental work. Production experiments will be undertaken to determine the true culture potential of Israeli Carp in Northeast Brazil.

3) Trip to Manaus--A two week trip to Manaus in January was undertaken by the author and two Brazilian biologists to gain some information on the feeding and spawning habits of Tambaqui and Pirapitinga. Both species of fish are common in the Manaus area and the large numbers of fish available in the local fish-markets allow for a more detailed study of the fishes biology than can be performed at the Pentecoste Research Station where a limited number of both species are available. Early mornings were spent in the local fish market collecting stomachs, gonads, scales and taking basic length and weight measurements. A total of 87 stomachs were collected and preserved from both species. Stomachs, scales and other data collected have not yet been analyzed but upon analysis, they should lead to some understanding of the food and spawning habits, growth under natural conditions and age at maturity of both Tambaqui and Pirapitinga.

Training and Visitors--As knowledge of the Convenio and Pentecoste Research Station spreads throughout Brazil and South America, an increasing number of people are seeking information, tours and training at DNOCS facilities. The Directoria of Fisheries has started a training program for DNOCS fishery biologists located in other states in Brazil and not connected with the regional

directoria of the state of Ceara. Other South American countries are asking to send biologists to Brazil to gain short-term training at DNOCS installations. The general training program lasts for approximately four weeks within which the trainee spends one week each studying fish technology, limnology and water quality analysis, fishery biology and reservoir sampling and fishculture.

These training programs and tours of DNOCS facilities are beginning to demand a significant portion of Convenio personnel time. Plans are being made by DNOCS to eliminate the haphazard scheduling of trainees so that DPAN personnel can better organize their time and training program. Efforts are being made to choose two months out of the year when training programs will be initiated and full attention of the convenio staff can be directed to instruction. A list of trainees and visitors to DNOCS fisheries facilities the past six months is listed below.

Trainees

Jose Farias	DNOCS	Salvador region
Nelson Cordeiro	Univ. Federal	Rio de Janeiro
Hugo Amorim	Univ. Federal	Rio De Janeiro
Geraldo Morais	DNOCS	Recife region
Paulo Florentino	DNOCS	Recife region
Isaias de Oliveira	DNOCS	Salvador region
Antonio Chastinet	Univ. Federal	
	Agronomy School	Salvador
Juan Rivaldi	Chief of the Division of Hunting, Fishing and Fishculture	Paraguay

Visitors

Rolano Mazzei	Centro de Investigaciones	
Ricardo Bastida	Centificas do Nucleo Nueva Esparta	Venezuela
Jose Amato	Dept. of Zoology Univ. Federal Santa Mari	Porto Alegre

Dr. Paulo Sawaia	Director of the Institute of Biosciences Univ. of Sao Paulo	Sao Paulo
Dr. Melquiades Paiva	Director of the Laboratory of Ocean Sciences Univ. of Ceara	Fortaleza
Dr. Joao Da Cruz	Institute of Marine Biology	Natal
Cramel Greene	Director of World Neighbors	Oklahoma City, U.S.A.
Dr. Jacques Bard	Director des Affaires Estrangeres, Centre Technique, Forestier Tropical Peche et Pisciculture	France
Dr. Kempton Webb	Director of the Depart. of Latin America Studies Columbia Univ.	U.S.A.
M. Bar Ilan	Director of Freshwater Fisheries, Ministry of Agriculture	Israel

Participant Training

Two Brazilian biologists working for DNOCS are now in the U.S. studying for M.S. degrees at Auburn University, Department of Fisheries and Allied Aquaculture. These two participants are the first two Brazilians to receive training leading to the M.S. degree in connection with this project. The DNOCS organization realizes the importance of training their personnel at the graduate level in the U.S. and they are making every effort to make candidates available for training. Two more participants are now studying English in preparation for studying at Auburn University in 1974. One candidate will receive one year of training in the field of fish nutrition while the second candidate will study for an M.S. degree in fishculture. The author feels that more graduate training at the graduate level is desirable so all efforts to recruit additional candidates will be continued.

Cooperation between DNOCS and University of Ceara

The author can report that some progress is being made in the attempt to bring the Laboratory of Ocean Sciences, University of Ceara, and the DNOCS fisheries research program together. The author had been pessimistic in his last semi-annual report about the possibilities of the two agencies forming a convenio and working together. With the establishment of the Directoria of Fisheries, DNOCS, a better line of communication between the two agencies has been established bringing some results. Under their own initiative, the organizations have arranged for a member of DNOCS, Directoria of Fisheries, to teach Limnology to a class of fisheries students at the University of Ceara. The author feels that other DNOCS biologists will have the opportunity to teach in the University in the near future. The author was invited to present a seminar to fisheries students and as a result of this visit by the author and several DNOCS biologists, an entire class of fisheries students spent a half day touring the Pentecoste Research Station and gaining first hand information on the types of research being performed. While these events are still a long way from the establishment of a formal working agreement, they are the first steps leading to understanding the mutual advantages to be gained by each party in forming a joint working relationship.

USAID/Brasilia--In the first nine months of this contract, there was a serious lack of communication between the Auburn Project and USAID/Brasilia. Through talks with Brasilia USAID staff, this lack of communication has been resolved and the author is now satisfied that lines of communication are open and the duties to be performed by both parties defined.

The two Auburn project staff members, director of the Directoria of Fisheries, Dr. Adhemar Braga, and DNOCS biologist, Helio de Melo, spent 3 days in Brasilia meeting with USAID personnel and Brazilian staff within the Department of Interior. The author feels that the results of these talks are a greater understanding of project objectives, strengths, limitations and deficiencies by USAID and Brazilian officials as well as an increased effort by USAID/Brasilia to provide backstop services to the Auburn project. With the aid of USAID/Brasilia, several problems within DNOCS that were hindering the progress of the project have been resolved. The author also has a better understanding of the help that USAID/Brasilia can provide and will not hesitate to inform Brasilia of problem areas in the future.

Auburn University--Auburn University staff in the U.S. has provided excellent backstopping services in the first year of the author's two year contract. With the untimely death of Dr. Homer Swingle, it is hoped that the level of communication and backstopping services will be able to continue at its past high level. The author feels that significant progress can be made to establish a sound fisheries research and training organization within DNOCS in the coming year before Auburn University's technical assistance will come to an end. The author asks that Auburn make every possible effort to continue its high level of technical backstopping in the year to come.

Future Plans

- 1) Present research projects will be continued and others initiated as the opportunity and pond space becomes available. Emphasis will be placed

on hybrid Tilapia fry production and production experiments utilizing hybrid Tilapias and monosex cultures of T. nilotica and hornorum. Production of Israeli Carp in monoculture and mixed culture with the hybrid Tilapia will also be studied. The author feels that those fish which have the best potential for immediate culture by local farmers should be given experimental preference.

2) Much experimental data is beginning to be collected and the author will make an effort to see that as much information as possible is written up and made available to Auburn University and the Brazilian Government for publication and distribution.