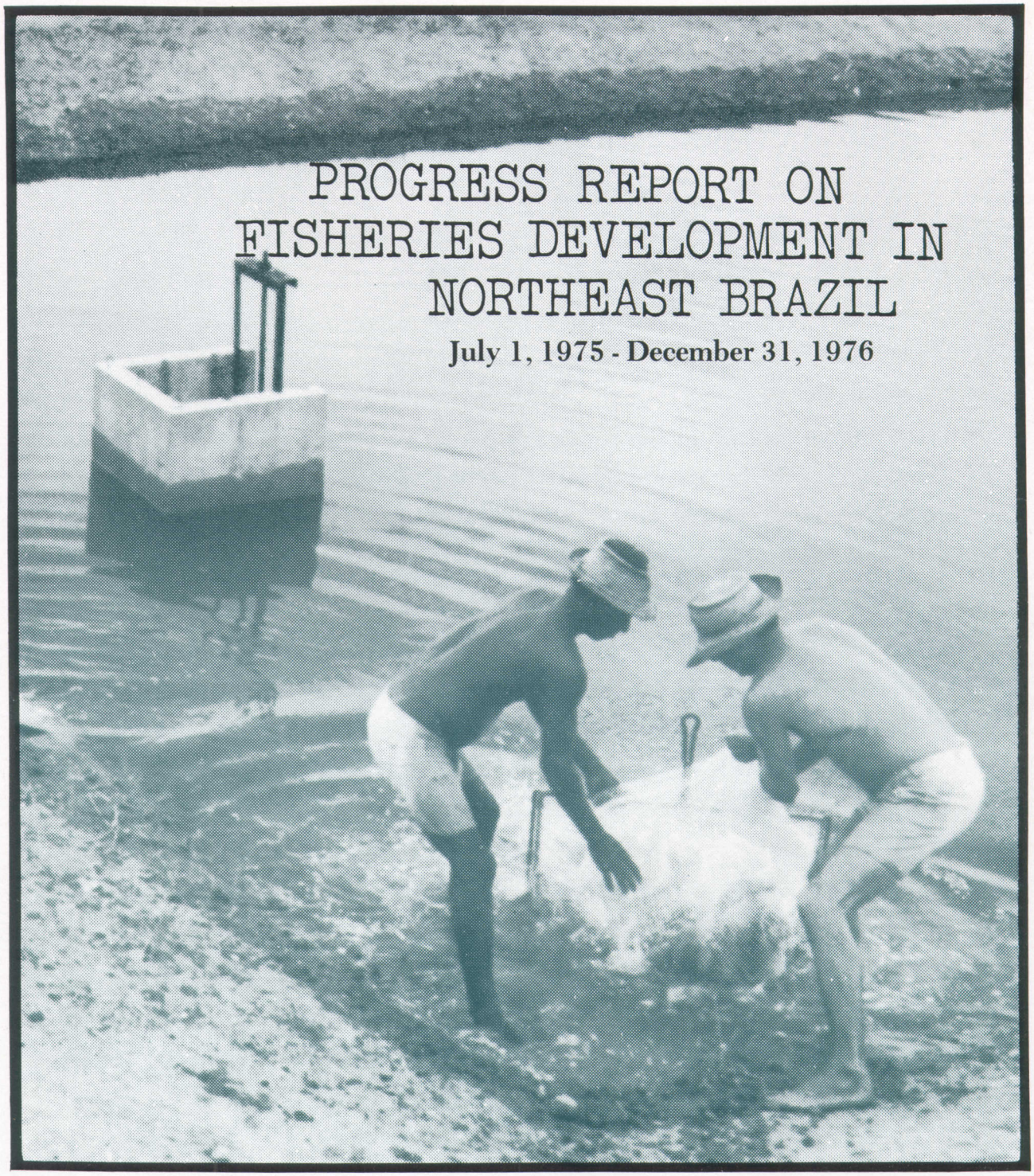

PROGRESS REPORT ON FISHERIES DEVELOPMENT IN NORTHEAST BRAZIL

July 1, 1975 - December 31, 1976

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CONTENTS

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PROGRESS REPORT ON FISHERIES DEVELOPMENT IN NORTHEAST BRAZIL

July 1, 1975 — December 31, 1976

Leonard L. Lovshin*

INTRODUCTION

AUBURN UNIVERSITY has been involved in improving the freshwater fisheries resources in Northeast Brazil since 1966 when various staff members participated in short-term work programs in that country. Since 1969, the University has provided technical assistance in the form of resident advisors to the Brazilian federal agency, DNOCS[1], in fish culture, reservoir management, and fish culture extension. The author arrived in Fortaleza, Ceara, in June 1972 and has been the fish culture advisory specialist since that date.

This report deals with the pertinent activities related to fish culture within the Centro de Pesquisas Ictiologicas during the period July 1, 1975 - December 31, 1976. Past developments in fisheries and fish culture in the Northeast of Brazil can be found in previous progress reports *(1, 2, 3, 5, 8)*.

* Assistant Professor, Department of Fisheries and Allied Aquacultures.

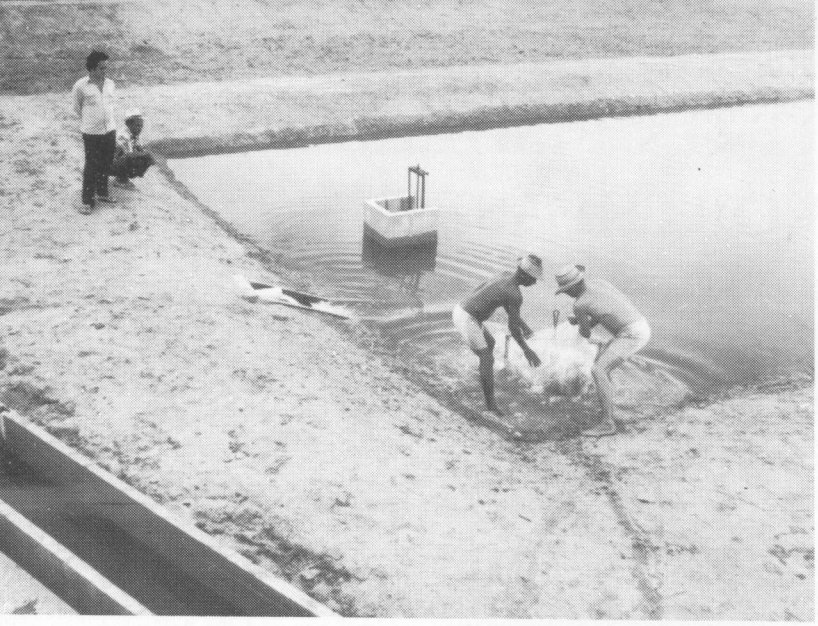
[1] Departamento Nacional de Obras Contra as Secas.

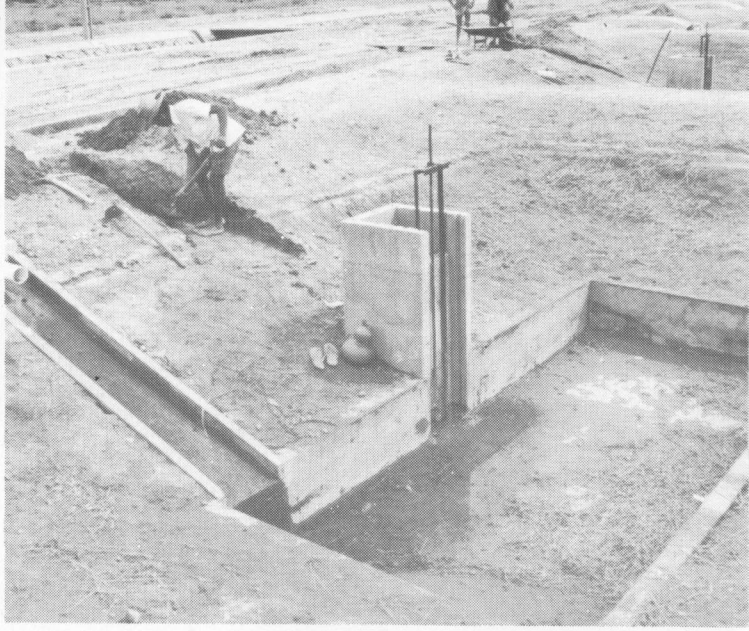
TRAINING AND TECHNICAL ASSISTANCE

The Centro de Pesquisas Ictiologicas is rapidly becoming recognized as one of the outstanding freshwater research organizations in Latin America. Demands on the research center's staff are continually increasing as requests for technical assistance and training increase. In the past year and a half, DNOCS biologists gave technical assistance to six Brazilian agencies located in the states of Bahia, Minas Gerais, Goias, Acre, and the Federal District. Assistance consisted of orientation and planning of fishery and limnological surveys and aid in selecting sites for fish hatcheries.

At the request of the Peruvian government, two DNOCS biologists and the author spent a month in Peru touring fisheries installations and advising Peruvian biologists on the best methods of culturing selected species of Amazonian fishes. During the reporting period, 50 students and scientists spent short study periods at the Centro de Pesquisas Ictiologicas, including 2 from Peru, 2 from Chile, 1 each from

The topography of Northeast Brazil is ideal for construction of inexpensive fish ponds. The ponds shown are fertilized by wastes from adjacent dairy and calf feedlots.





DNOCS has made a commitment to fishculture research by developing a research facility which presently contains 151 earthern and concrete ponds with a total water surface of 11.0 hectares. The 0.4-hectare experimental units shown are typical of the excellent research ponds available.

Panama and Colombia, and 10 student trainees from local universities. The local university students were in their final year of studies and had won scholarships to study for a period of 6 months to 1 year in the discipline of their choice.

DNOCS also administered a third course for 11 SUDEPE[2] scholarship students. These students spent 2 months at DNOCS fishery installations, including 1 month with the Centro de Pesquisas Ictiologicas. Upon completion of this special training, most of the graduates departed for their respective jobs with SUDEPE.

Recently, four officials from the Colombian government visited DNOCS fishery installations to personally evaluate the research center's potential as a fisheries training center. These fisheries officials were interested in short term training for Colombian biologists in the practical aspects of fishery biology and fish culture.

Short term training is now available through DNOCS in such specialty areas as intensive and extensive fish culture, reservoir management, collection of commercial fishery statistics, hatchery management including the spawning and culturing of a number of Amazonian fishes, hormone spawning of fish, and reservoir limnology.

INSTALLATIONS AND FACILITIES

The headquarters unit for the Centro de Pesquisas Ictiologicas presently is located in Fortaleza, Ceara. It is anticipated that the entire Centro de Pesquisas Ictiologicas will move to Pentecoste, Ceara, when permanent facilities are completed.

DNOCS has embarked on a large-scale building program in Pentecoste located 100 kilometers west of Fortaleza. Programmed for 1976 and 1977 are the construction of a 1,000-square meter laboratory and teaching complex, administration building, warehouse, garage-machine shop, fish technology building, and net fabrication and storage house. The building complex will be surrounded by pond facilities on 120 hectares of land located below the Pereira de Miranda Reservoir at Pentecoste. A restaurant, dormitory, and housing for technicians and visiting scientists are planned for construction during the second phase of the building program. Construction has been completed recently on ten 2,500-square meter earthen ponds; a small fish hatchery unit modeled after larger DNOCS hatcheries that contains 28 concrete ponds ranging in size from 40.3 to 80.5 square meters; six 100-square meter earthen ponds for tilapia hybrid spawning experiments; and a wet-laboratory unit that will house twenty 500-l cement-fiber tanks and forty 20-l aquaria. At present, the Centro de Pesquisas Ictiologicas has 151 earthen and concrete ponds ranging in size from 40.3 to 10,000 square meters. Total water area is 11.0 hectares.

When the research center is completed in 1980, the facility will contain over 200 earthen ponds, comprising over 20 hectares of water, and related wet-laboratory installations. DNOCS will possess excellent installations for research and training in fish culture, reservoir management, and limnology. With the help of USAID, DNOCS hopes to develop Pentecoste installations into a regional center for fisheries training and research for Latin America.

AQUACULTURAL RESEARCH PROGRAM

A program of aquacultural research has been in progress since 1970, directed towards evaluating Brazilian fishes for culture potential and developing culture systems for use in DNOCS irrigation projects and by private farmers. Exotic species with known culture potential are also being investigated. This report summarizes research performed over the past year and a half, primarily in the earthen pond research complex.

Experiments with Tilapias[3]

At present, tilapia offer the greatest potential for immediate culture in Northeast Brazil. Past research results can be reviewed in publications by Lovshin, Da Silva, and Fernandes *(7)*, Lovshin *(8)*, and Lovshin and Da Silva *(9)*. The majority of research on tilapias is presently centered on the all-male tilapia hybrid produced by crossing male *Sarotherodon hornorum* with female *Sarotherodon nilotica*.

[2] Superintendencia do Desenvolvimento da Pesca.

[3] Tilapia species reported on in this paper have been reclassified recently and presently are included in the genus *Sarotherodon*.

The tilapia hybrid is an excellent culture fish and enjoys wide consumer acceptance. Production of the tilapia hybrid when stocked at 30,000 fingerlings per hectare and fed agricultural by-products reaches 10,000 kilograms per hectare per year with an average size of 400 grams. However, widespread, large scale culture is limited by short supplies of fingerlings. Research now being conducted may provide hatchery methodology to alleviate this problem.

Tilapia hybrids continue to give excellent results when intensively cultured utilizing agricultural waste products or organic manures as feed and fertilizer. Past research demonstrated that tilapia hybrids stocked at 10,000 per hectare and fed agricultural waste products reached an average weight of 200-300 grams in 6 months, producing 2,000 to 3,000 kilograms per hectare.

To test the effect of increased stocking rates on production, DNOCS biologists investigated the growth and production of tilapia hybrids when stocked at 13,000, 15,000, 17,000, 19,000, 21,000, 23,000, 25,000, 27,000, 29,000, and 31,000 per hectare. The fish were stocked in 350-square meter earthen ponds and each stocking rate was represented by a single pond.

The hybrids were fed a ration of 50 percent babacu cake (a type of palm nut cake containing 24 percent protein) and 50 percent cottonseed cake (23 percent protein) at 5 percent of the total weight of the fish in each pond. The fish were fed 5 days a week. Feeding rates were recalculated each month based on seine samples of the ponds. Sampling consisted of weighing and measuring 50 fish from each pond. Each pond was fertilized with a total of 19 kilograms (540 kilograms per hectare) of triple superphosphate and ammonium sulfate applied at 2-week intervals over the first 7 months of the experiment. Table 1 shows the results of this experiment at the end of 367 days.

Productions were the highest yet obtained in research with the tilapia hybrid. The productions are even more impressive considering that only vegetable materials were fed to the fish. It is the first time that 1 kilogram of marketable size fish has been obtained from 1 square meter of standing water at Pentecoste. Preliminary analysis of the data indicated that increasing stocking rates had a positive effect on production.

Conversion of feed to fish flesh was good up to 6 months, average at 10 months, and poor at 12 months. From the tenth month until harvest, conversion rates increased sharply, probably caused by extremely poor water quality.

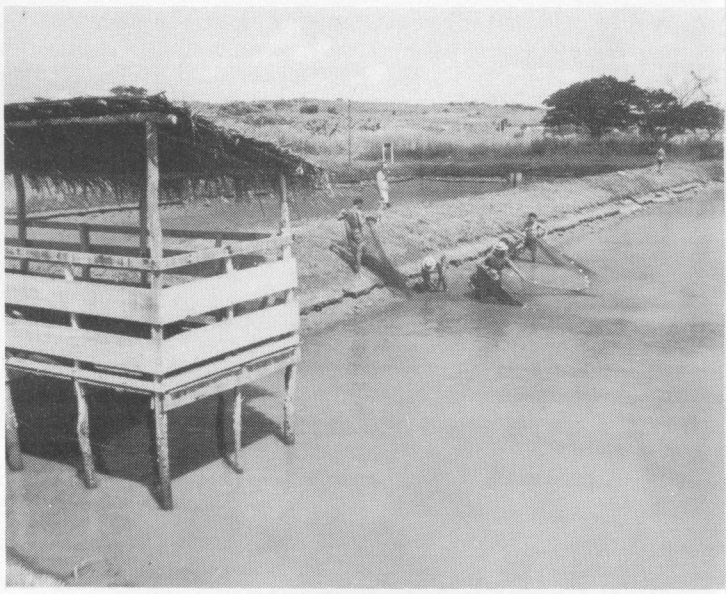
The purpose of the experiment was to determine at what time growth rates decreased and mortality occurred with the tilapia hybrids when stocked in standing water and fed agricultural by-products. For this reason, fish were fed and the ration was increased even when fish were obviously being stressed by poor water quality. The tilapia hybrid is extremely tolerant. Fish were observed at the water surface night after night seeking oxygen during the last month of the experiment. A 24-hour dissolved oxygen test was run 1 week before harvest. Dissolved oxygen readings were taken at the water surface and near the bottom in all ponds at 4-hour intervals starting at 12:00 noon. Tilapia hybrids survived in water having less that 0.8 p.p.m. of dissolved oxygen for 8 to 10 hours during the night. Four days after the extremely low dissolved oxygen readings were recorded, the first fish kill of tilapia hybrids at Pentecoste occurred. It is not known if the kill was a direct result of low dissolved oxygen or a combination of several water quality factors. Several other

TABLE 1. SUMMARY OF RESULTS WITH TILAPIA HYBRIDS STOCKED AT VARIOUS LEVELS

Performance measure	Result, by stocking rate per hectare									
	13,000	15,000	17,000	19,000	21,000	23,000	25,000	27,000	29,000	31,000
Fish stocked/pond	455	525	595	665	735	805	875	945	1,015	1,085
Av. initial weight, g	25	27	26	38	22	22	23	23	25	25
Av. final weight, g	452	466	495	456	492	384	444	416	353	410
Production/pond, kg	197	245	279	303	354	309[1]	371	375	356	419
Production/ha, kg	5,629	7,000	7,971	8,657	10,114	8,828	10,599	10,714	10,171	11,971
Survival, pct.	96	100	95	100	98	100	96	95	99	94
Feed conversion at 6 months.	3.3	2.8	2.7	3.2	2.4	2.8	3.3	3.0	3.0	2.7
Feed conversion at 10 months.	4.5	4.6	4.0	4.5	4.4	4.1	3.8	4.2	4.3	3.7
Feed conversion at 12 months.	6.0	6.3	6.2	6.2	6.2	6.7	5.9	6.2	6.3	6.2
Ration fed/pond, kg	1,124	1,465	1,648	1,732	2,093	1,947	2,074	2,168	2,067	2,413

[1] Included are 62 kg of fish that died due to poor water quality 2 days before harvest.

Productions of 2,900 kilograms per hectare per year can be obtained by washing hog manure and feed wastes from pens into ponds stocked with 8,000 tilapia hybrids per hectare. Fish average 206 grams after 6 months of culture.



ponds being fed at a higher daily rate suffered no fish mortality. The pond stocked at 31,000 per hectare was fed daily 20 kilograms (564 kilograms per hectare) for 2 months without a fish kill.

These data indicate that even higher productions can be expected from tilapia hybrids under the experimental conditions present at Pentecoste.

Da Silva, Lovshin, and de Melo (unpublished data) tested the all-male tilapia hybrids raised in conjunction with feeder pigs. Three ponds of 1,000 square meters were stocked with 25-gram hybrid fingerlings at the rate of 8,000 per hectare. Pig sties were constructed on the margins of three ponds and 7 pigs (70 per hectare) averaging 17 kilograms were placed in each sty. The pigs were not allowed to enter the ponds. The sties were cleaned daily and all waste products washed into the ponds. The pigs were fed daily at 5 percent of their body weight a ration consisting of manioc-30 percent, wheat bran-20 percent, corn-15 percent, babacu cake-15 percent, and grass-20 percent. This ration contained 10 percent protein. After 189 days, 1,490 kilograms per hectare of tilapia hybrids averaging 205 grams each were harvested. Pigs averaged 60 kilograms each. Conversion rate of feed to pigs was 7.1 to 1; of feed to pigs and fish combined, the rate was 5.9 to 1.

Da Silva, Carneiro-Sobrinho, and de Melo (unpublished data) recently terminated a second experiment similar to the above mentioned one, testing tilapia hybrid and pig culture. Six pigs per sty (60 per hectare) were fed a daily ration of corn, babacu cake, meat meal, and grass at 5 percent of their body weight. The ration contained 11.6 percent protein. Tilapia hybrids averaging 31 grams each were stocked at the rate of 10,000 per hectare. The fish were fed cottonseed meal at 2 percent of their body weight, 6 days a week. After 193 days, 3,043 kilograms per hectare of tilapia hybrids averaging 304 grams each were harvested. Average initial weight of the pigs was 16 kilograms and average final weight was 55 kilograms. Conversion rate of feed to pigs was 6.4 to 1 and of feed to fish it was 1.7 to 1.

Three ponds of 1,000 square meters were also stocked with 25-gram tilapia hybrid fingerlings at the rate of 8,000 per hectare and fertilized with chicken manure at 50 kilograms per week (500 kilograms per hectare per week). The chicken manure contained 16 percent protein and consisted of 79 percent organic matter. After 189 days, 1,350 kilograms per hectare of tilapia hybrids averaging 186 grams each were harvested. Conversion rate of chicken manure to fish was 10 to 1.

Experiments with Tilapia and Tucunare

Because of the problems encountered in producing large numbers of tilapia hybrid fingerlings, DNOCS biologists are now studying the production capacity of *Sarotherodon nilotica* when stocked with a predator fish species. Besides the biological problems involved with producing and maintaining pure strains of broodstocks, DNOCS fish hatcheries do not have sufficient facilities to produce the large numbers of tilapia hybrid fingerlings needed to meet present demand. However, with existing installations, large numbers of pure *Sarotherodon nilotica* fingerlings can be easily produced. The predator tucunare, *Cichla ocellaris*, has

been produced for many years in DNOCS hatcheries and production of large numbers of fingerlings of this species is easily accomplished.

To test the efficiency of tucunare in controlling the excessive reproduction of tilapia, various ratios of tucunare and *Sarotherodon nilotica* were stocked into 400-square meter earthen ponds. These ponds were new and exhibited a higher than normal rate of seepage. All six ponds were stocked with pure *Sarotherodon nilotica* fingerlings at the rate of 10,000 per hectare. Predators were stocked in the predator to tilapia proportions of 1:3, 1:6, 1:9, 1:12, and 1:15. One control pond did not receive tucunare.

All ponds received a total of 1,349 kilograms (33,725 kilograms per hectare) of cattle manure applied at approximately 2-week intervals. Fish were fed available agricultural waste products, which included rice and wheat bran, castor bean meal, and babacu cake at 5 percent of their body weight for the first 6 months and 3 percent of body weight the remaining 4 months. The fish received the ration 6 days a week. Feeding rates were changed monthly using the results of monthly seine samples.

After 302 days, ponds were drained and all fish were counted and weighed by species, sex, and size group. An average of 2,491 kilograms per hectare was produced with a predator while the control pond without a predator produced 4,944 kilograms of tilapia per hectare, or about twice the yield with a predator, Table 2. However, few tilapia reached marketable size in the control pond. Total control of tilapia reproduction was not obtained in any pond, but only in the pond with a ratio of 15 tilapia to 1 tucunare did fewer than 90 percent of the fish reach marketable size. While male tilapias grew twice as fast as females, all the stocked females reached harvestable size. Survival of both *Sarotherodon nilotica* and tucunare was poor. The reason for this is not known. This initial experiment demonstrated that good production of *Sarotherodon nilotica* can be obtained with tucunare as a predator to control reproduction at ratios of up to 12 tilapia to 1 tucunare. The predator-prey ratio of 15 tilapia to 1 tucunare gave inconclusive results because of low predator survival and will have to be retested.

TABLE 2. SUMMARY OF PERFORMANCE OF *SAROTHERODON NILOTICA* RAISED IN ASSOCIATION WITH THE PREDATOR, *CICHLA OCELLARIS*, AT VARIOUS RATIOS

Performance measure	Result, by ratio of *S. nilotica* to predator					
	All tilapia	8:1	6:1	9:1	12:1	15:1
Av. initial wt. of predator, g	----	12	11	11	10	13
Av. initial wt. of *S. nilotica*, g	14	15	14	15	14	14
Av. final wt. of predator, g	----	47	76	72	117	189
Av. final wt. of *S. nilotica*						
Males, g	----	365	466	435	387	294
Females, g	----	179	201	189	169	154
Av. both, g	----	272	333	312	278	224
Production/ha of *S. nilotica* (100 g+), kg	4,944	2,351	2,846	2,779	2,480	1,998
Wt. of tilapia marketable (100 g+)[1], kg	0	95	94	96	99	83
Tilapia survival, pct	----	85	86	86	86	86
Predator survival, pct	----	57	62	75	64	56
Food conversion	2.4:1	5.1:1	4.1:1	4.2:1	4.7:1	5.8:1

[1] Weight of tilapia marketable (percent) = $\frac{\text{weight of tilapia over 100 g}}{\text{total weight of tilapia}} \times 100$

The most serious current problem facing the development of tilapia hybrid culture in the Northeast is the lack of proper installations and techniques to produce adequate numbers of hybrid fingerlings to meet the demand of commercial growers. The problems in producing hundreds of thousands of fingerlings were not fully appreciated until the demand by private farmers increased rapidly.

Optimum numbers of male and female broodstock needed to produce the greatest number of young have not been determined. The greatest problem encountered is the large variation in numbers of fry obtained between ponds stocked with equal numbers of broodstock. Some ponds produce several thousand fry while others produce only hundreds. Occasionally, a spawning pond, drained after 3 months, produces not one fry.

The exact reason for this large variation in fry production is difficult to determine. The leading hypothesis is that the male *Sarotherodon hornorum* and female *Sarotherodon nilotica* are far enough apart taxonomically that their spawning behavior differs to the extent that only a relatively small portion of the sexually mature broodstock of the two tilapia species successfully complete the spawning act. Research is now underway to develop methods of producing large numbers of tilapia hybrid fry with consistency.

Initial research showed that a ratio of 5 females to 1 male tilapia gave results similar to that obtained when using 2 females to 1 male. Early research also demonstrated that younger females and males, weighing less that 100 grams, tended to produce more offspring than older, larger brooders, and that 50 females and 10 males in a 350-square meter spawning pond gave better results than lesser numbers of brooders. Theoretically, young broodstock that have not spawned before may form "families" that aid in the spawning performance.

Experiments with Pirapitinga (Colossoma bidens)[4]

Lovshin, Da Silva, Fernandes, and Carneiro-Sobrinho *(6)* found that pirapitinga has excellent culture potential providing the fish could be induced to spawn under hatchery conditions. Several earlier attempts to artificially spawn pirapitinga proved unsuccessful. However, Da Silva and Carneiro-Sobrinho (unpublished data) successfully spawned this species in March 1976. Sexually mature fish of about 3 kilograms and 4 years of age were injected at 6-hour intervals with pituitaries taken from curimata comun, *Prochilodus cearensis*, Table 3. After the third injection, males and females were placed together in a 4-square meter concrete tank in the proportion of 2 males to 1 female. The fish subsequently spawned in the tanks. The fertilized eggs were collected and placed in incubators. Hatching success was

[4] Originally described as *Mylossoma bidens*.

TABLE 3. SUMMARY OF THE DATA RELATING TO THE FIRST ARTIFICIAL SPAWNING OF PIRAPITINGA *(COLOSSOMA BIDENS)* WITH INJECTIONS OF CURIMATA COMUM *(PROCHILODUS CEARENSIS)* PITUITARIES

	First injection	Second injection	Third injection	Spawned
Date	3/10/76	3/11/76	3/11/76	3/11/76
Hour	9:00 p.m.	3:00 a.m.	9:00 a.m.	12:00 noon
No. of pituitaries in 2 cm^3 solution[1]	12	12	18	
Dosage per fish				
Male (3.20 kg)	0.40 cm^3	0.40 cm^3	0.40 cm^3	
Male (3.40 kg)	0.75 cm^3	0.75 cm^3	0.80 cm^3	
Female (4.40 kg)	0.40 cm^3	0.40 cm^3	0.40 cm^3	

[1] Donor fish averaged 500 g weight.

high but all the fry died within 3 days. Exact causes of this mortality are not known. A second attempt to spawn pirapitinga 2 weeks later using the same technique resulted in a partial spawn, Table 4. Fry from the latter spawn were taken to a DNOCS fish hatchery with better nursery conditions. Of approximately 3,000 fry, 156 survived to fingerling size. This is the first time that pirapitinga has been successfully spawned and raised to fingerling size. With improved spawning and rearing techniques, large numbers of pirapitinga fingerlings can probably be produced on a regular basis.

TABLE 4. SUMMARY OF THE DATA RELATING TO THE SECOND ARTIFICIAL SPAWNING OF PIRAPITINGA *(COLOSSOMA BIDENS)* WITH INJECTIONS OF CURIMATA COMUM *(PROCHILODUS CEARENSIS)* PITUITARIES

	First injection	Second injection	Third injection	Spawned
Date	4/6/76	4/6/76	4/7/76	4/7/76
Hour	6:00 p.m.	12 midnight	6:00 a.m.	11:15 a.m.-1:00 p.m.
No. of pituitaries in 1 cm^3 solution[1]	12	12	24	
Dosage per fish				
Male (3.20 kg)	0.30 cm^3	0.30 cm^3	0.30 cm^3	
Male (2.20)	0.30 cm^3	0.30 cm^3	0.30 cm^3	
Female (2.68 kg)	0.40 cm^3	0.40 cm^3	0.10 cm^3	

[1] Donor fish averaged 500 g weight.

Experiments with Tambaqui (Colossoma macropomum)[5]

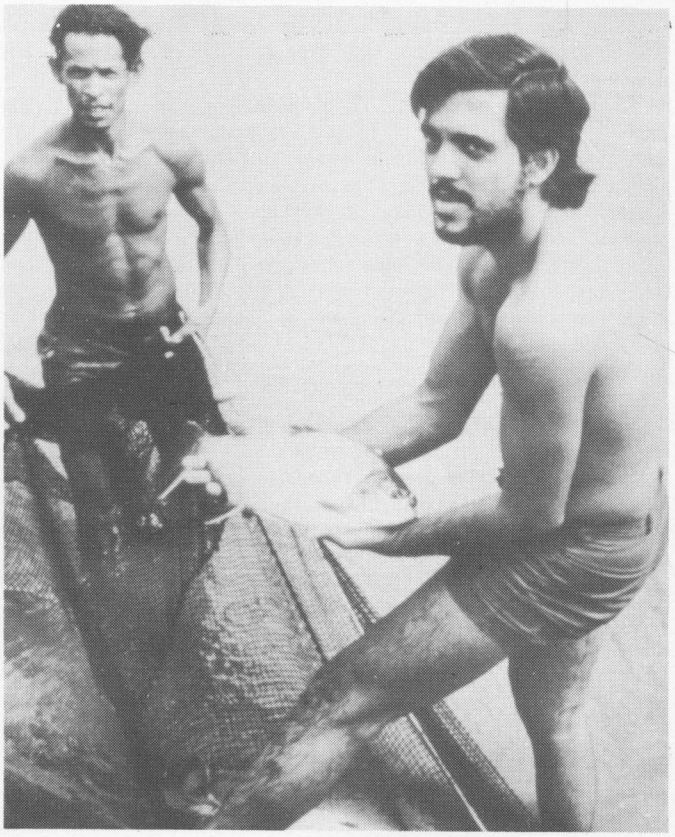
Research by Lovshin, Da Silva, Fernandes, and Carneiro-Sobrinho *(6)* demonstrated that tambaqui also has excellent culture potential if this species can be spawned to provide fingerlings for stocking purposes. To date, a number of spawning attempts over a 3-year period have been unsuccessful although several abortive spawns have been obtained using pituitary injections from the donor fish, *Prochilodus cearensis.*

Experiments with Curimata Comum (Prochilodus cearensis)

Curimata comum, a fish native to Northeastern Brazil, for many years has been artificially spawned and raised to fingerling size in DNOCS fish hatcheries and subsequently stocked into reservoirs. This fish is readily accepted by local consumers, making it a good candidate species for intensive fish culture.

Research was carried out by DNOCS biologists to determine the growth and production of curimata comum at a number of different stocking rates. Ten earthen ponds of 355 square meters were stocked with curimata comum at levels ranging from 1,000 to 10,000 per hectare. Fish were fed agricultural waste products, principally wheat bran and babacu cake, at 5 percent of their body weight daily, 6 days a week. Fish were sampled monthly and new feeding rates were calculated from sample results. After 187 days, ponds were drained and all fish were counted and weighed. Production was poor at all stocking rates. Curimata stocked at the lowest densities did not attain a marketable average weight of 100 grams after 6 months, and the maximum production per hectare was 486 kilograms. Conversion rates were poor, ranging from a low of 7.0 to 1 to a high of 11.3 to 1. Data in Table 5 indicate that curimata comum is not an acceptable fish for intensive culture using the culture technique applied in this experiment.

[5] Originally described as *Colossoma bidens.*



Pirapitinga *(Colossoma bidens)* is one of several Brazilian species being tested for culture potential at Pentecoste. This fish has been artificially spawned and promises to be an excellent alternative to the tilapia hybrid culture system.

TABLE 5. SUMMARY OF RESULTS OF PRODUCTION OF CURIMATA COMUM *(PROCHILODUS CEARENSIS)* IN EARTHEN PONDS AT VARIOUS LEVELS OF STOCKING

Performance measure	Result, by stocking rate per hectare									
	1,000	2,000	3,000	4,000	5,000	6,000	7,000	8,000	9,000	10,000
Fish/pond	35	71	106	142	177	213	248	284	319	355
Av. initial weight, g	11	18	11	14	12	13	13	13	12	13
Av. final weight, g	95	60	74	85	63	69	71	53	45	37
Production/pond, g	2,649	4,150	7,430	11,190	10,330	14,170	17,344	14,504	14,130	12,026[1]
Production/ha, kg	74	116	208	313	289	397	486	406	396	337
Survival, pct	80	97	94	92	93	96	98	96	98	93
Quantity of ration fed, g	19,095	24,920	43,630	67,655	68,240	91,770	98,460	90,180	96,510	84,090
Feed conversion	8.4	8.7	7.0	7.3	8.3	8.1	7.0	8.3	9.4	11.3
No. of days in experiment	187	187	187	187	187	187	187	187	187	187

[1] Does not include 12 kg of tilapia found in pond at harvest.

Experiments with Curimata Pacu (Prochilodus argenteus)

Native to the Sao Francisco River, curimata pacu was introduced into Ceara by DNOCS biologists and is now being artificially spawned and raised to fingerling size for distribution in local waters. While similar to curimata comum in appearance and life history, curimata pacu grows to a much larger size. For this reason, curimata pacu was tested by DNOCS fishery biologists for growth and productivity in six 355-square meter earthen ponds at various levels of stocking. Fingerlings were stocked at 1,000, 3,000, 4,000, 5,000, 7,000, and 9,000 per hectare and fed babacu cake at 5 percent of their weight daily, 6 days a week. Feeding rates were readjusted using monthly seine samples. After 301 days, the ponds were drained and all fish were counted and weighed. Fish at all stocking rates reached a marketable size of 100 grams, Table 6; however, food conversion rates ranged from 5.8 to 1 to 8.7 to 1. A comparison of the average weights of curimata comum at harvest and curimata pacu after 6 months demonstrates that curimata pacu grows more rapidly under similar cultural conditions and average initial weights. Based on this experiment, curimata pacu still cannot be considered a good fish for intensive culture.

TABLE 6. SUMMARY OF RESULTS OF PRODUCTION OF CURIMATA PACU *(PROCHILODUS ARGENTEUS)* IN EARTHEN PONDS AT VARIOUS LEVELS OF STOCKING

Performance measure	Result, by stocking rate per hectare					
	1,000	3,000	4,000	5,000	7,000	9,000
Fish/pond	35	105	140	175	245	315
Av. initial wt., g	14	12	13	14	12	13
Av. wt. at 6 mo., g	149	96	156	96	96	83
Av. final wt., g	199	104	158	153	120	145
Production/pond, g	6,366	10,468	26,134	25,595	23,041	34,227
Production/ha, kg	178	293	732	717	645	958
Survival, pct.	91	95	100	95	78	75
Quantity of ration fed, g	45,650	88,750	188,290	149,410	200,430	248,180
Feed conversion	7.2 to 1	8.5 to 1	7.2 to 1	5.8 to 1	8.7 to 1	7.3 to 1
No. of days in experiment	301	301	301	301	301	301

Experiments with Channel Catfish (Ictalurus punctatus)

In October 1972, channel catfish fry were introduced to Northeast Brazil from the United States after having been examined and found free of parasites and disease. At present 120 broodstock 4 years old and averaging about 4 kilograms each are divided equally between two 5,000-square meter earthen ponds. The ponds contain tilapia and shrimp as forage for the broodstock and the fish receive a pelleted ration daily. Growth of the fry received from the United States has been excellent due to favorable climatic and water quality conditions. The ponds are equipped with spawning boxes. Two spawns to date have been obtained from one pond and none from the second pond. This poor spawning record substantiates observations from other tropical regions that channel catfish are unable to consistently spawn naturally in warm, tropical waters, which probably makes this species an unlikely candidate for intensive culture in Northeast Brazil.

FISH CULTURE EXTENSION

There are now 16 farmers raising fish in the Northeast, most located in the state of Ceara. The total pond area in water is about 5 hectares. There is strong farmer interest in raising tilapia, and the demand for hybrid fingerlings is greater than the supply. This is the principal problem facing the expansion of intensive fish culture. Farmers that are raising fish are producing large crops of hybrids resulting in high economic returns. Carneiro-Sobrinho, Fernandes, and Jensen (unpublished data) made an economic study of two of the largest farms in the region. One of these, Passagem Franca, has been farming fish for over 2 years. The first crop of tilapia hybrids produced in the farm's 8,000-square meter semi-natural pond fully paid pond construction costs and still left the farmer with a profit of Cr$3,146, equivalent to $370 U. S. *(4)*. This pond was constructed by damming a valley below a farm reservoir and using water from the reservoir to fill the fish pond. The pond was stocked for the second crop with 8,000 tilapia hybrids having an average weight of 13 grams. The fish were fed daily a ration of wheat bran at 3 percent of total weight of fish in the pond. This ration was supplemented with liberal additions of cow and chicken manure.

After 5 months, fish were harvested daily over a 2-month period. Harvest was by cast-net, nook and line, and draining. Average weight of the hybrids was 283 grams and the total production was 1,989 kilograms (2,486 kilograms per hectare). Survival of tilapias was calculated at 87 percent. Profit for the 7-month period was Cr$8,735.00 ($1,027.69 U.S.), Table 7.

TABLE 7. COST-BENEFIT ANALYSIS OF THE INTENSIVE CULTURE OF TILAPIA HYBRIDS IN A 0.8-HECTARE POND ON THE PASSAGEM FRANCA FARM

Item	Amount	
1. Costs		
Fixed costs		
Guard service	Cr$ 600.00	
Pond maintenance	200.00	
Total fixed costs		Cr$ 800.00
Variable costs		
Wheat bran (1,120 kg)	550.40	
Chicken manure (6m³)	450.00	
Harvest labor	400.00	
Total variable costs		Cr$ 1,400.40
TOTAL COST		Cr$ 2,200.40
2. Revenues		
Gross income (1,988.50 kg at Cr$5.50)		Cr$10,936.75
Net income		Cr$ 8,736.35 ($1,027.69 U.S.)
3. Construction of ponds[1]		Cr$ 5,590.35

[1] Cost of pond construction could be paid for with profits earned in culture period.

After 5 months, fish were harvested daily over a 2-month period. Harvest was by cast-net, nook and line, and draining. Average weight of the hybrids was 283 grams and the total production was 1,989 kilograms (2,486 kilograms per hectare). Survival of tilapias was calculated at 87 percent. Profit for the 7-month period was Cr$8,735.00 ($1,027.69 U.S.), Table 7.

TABLE 8. COST-BENEFIT ANALYSIS OF THE INTENSIVE CULTURE OF TILAPIA HYBRIDS IN TWO PONDS TOTALING 1.5 HECTARES ON THE TRAPIA FARM

Item	Amount	
1. Costs		
Fixed costs		
Guard service	Cr$ 1,000.00	
Harvest equipment (nets)	200.00	
Pond maintenance costs	200.00	
Total fixed costs		Cr$ 1,400.00
Variable costs		
Harvest labor	700.00	
Total variable costs		Cr$ 700.00
TOTAL COST		Cr$ 2,100.00
2. Revenues		
Gross income (3,520 kg at Cr$ 5.50)		Cr$19,360.00
Net income		Cr$17,260.00 ($2,031.00 U.S.)
3. Construction of ponds[1]		Cr.$ 6,000.00

[1] Cost of pond construction could be paid for with profits earned in first culture period.

A second farm, Trapia, included two semi-natural ponds of 5,000 square meters and 10,000 square meters. These ponds were also constructed by building a series of earthen dams below a farm reservoir. The smaller pond was stocked with 5,000 tilapia hybrids averaging 25 grams and the larger one received 5,000 fingerlings of 26-gram average weight. The main farm enterprises include milk cows, chickens, and pigs. Waste products from these animals were used to fertilize the ponds. Each pond received an initial application of 500 kilograms of chicken manure before stocking the fish and then 500 kilograms of chicken manure every 15 days until harvest. A pig sty was placed on the margin of each pond; the smaller pond had a sty with 15 pigs and the larger one had a sty with 16 pigs. The pigs were fed the waste curds from a cheese making process that utilized the milk from the cows. The pig waste products were washed into the ponds daily. No other ration was used and the manures added periodically cost nothing.

After 6 months of growing time, the ponds were harvested daily over a 2-month period by cast-net, hook and line, and draining. The fish from both ponds averaged 400 grams and the total production was 3,520 kilograms (2,347 kilograms per hectare) from both ponds. Even when pond construction costs were deducted, the net profit from these two ponds was Cr$11,260 ($1,324.70 U. S.), Table 8.

Two fish culture projects have been initiated in DNOCS irrigation projects. A pond of 1.2 hectares has been built and stocked in the state of Paraiba and a second pond of 0.7 hectare has been stocked in the state of Pernambuco. Before the end of the year, seven ponds consisting of 2 hectares of water should be completed and in production at irrigation projects in the state of Ceara.

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