Progress Report on Fisheries Development in Brazil

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CONTENTS

COVER PHOTO. This day's catch from a local reservoir will supply high quality fish protein to supplement the diets of several families.

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INTRODUCTION

In continuation of the USAID technical assistance program to the DNOCS[2], Directorate of Fisheries and Fisheculture, an agreement was signed by SUDENE[3], DNOCS, and USAID in March 1972 providing technical assistance to DNOCS for intensive fisheculture extension.

Developing a fisheculture extension service is part of this project's purpose, as stated in other interagency agreements, to "establish within DNOCS the capacity to carry out fisheries research, improve and encourage extension services, and develop freshwater fisheries resources." Development of an extension service makes it possible to attain the project's goal of "increasing overall production of animal protein from fish through introduction of fisheculture to farm ponds."

During the author's tour of duty from May 1972 to June 1974, substantial progress was made toward developing a viable, autonomous fisheculture extension service within DNOCS. Also, intensive fisheculture was introduced to farm ponds in the Northeast as foreseen in the project goal. Marketable fish originating from intensive farm pond culture should, in time, substantially increase fish production in Brazil's Northeast. This, in turn, will improve the general well-being of the people by increasing the amount of protein available for human consumption and by creating new investment and job opportunities.

This report will summarize and evaluate USAID technical assistance in fisheculture extension carried out under the Auburn University Contract AID csd-2270, Task Order 8. A summary of extension activities in intensive and less intensive fisheculture will be followed by a discussion of counterpart training and recommendations.

BACKGROUND

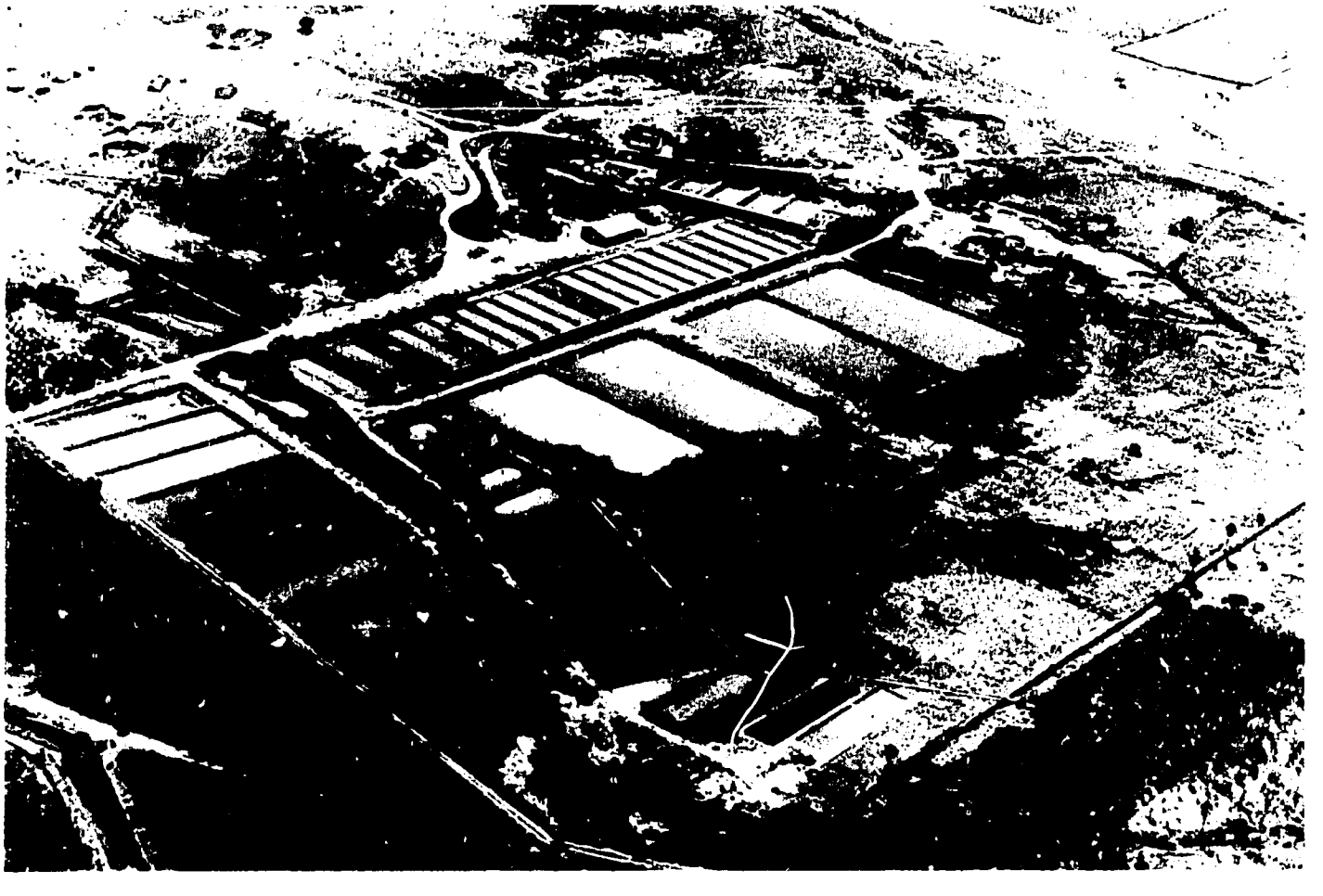
Before the agreement providing technical assistance in fisheculture extension to DNOCS was signed in 1972, the only extension program existing within the DNOCS organization was in fish technology. Results of intensive fisheculture research, which was begun in 1969 at the DNOCS Center for

[1] Research Associate, Department of Fisheries and Allied Aquacultures and International Center for Aquaculture.

[2] Departamento Nacional de Obras Contra as Secas (National Department of Works Against the Drought).

[3] Superintendencia do Desenvolvimento do Nordeste (Superintendency for the Development of the Northeast).

Aerial view of the Intensive Fishculture Research Station in Pentecoste, Ceara. Built in 1969, this station now has 56 research ponds.



Fisheries Research in Pentecoste, Ceara, had already clearly demonstrated that intensive fishculture could be a viable agricultural enterprise in the Northeast. Thus, there was an evident need for a fishculture extension service. Responding to this need, the USAID technical assistance project of intensive fishculture extension provided means of making new knowledge from research immediately available to farmers and other people of the Northeast.

INTENSIVE FISHCULTURE EXTENSION

No fishculture tradition exists in Brazil as it does in certain Asian or European countries, but it was believed that farmers could be motivated to invest in such an enterprise if it were demonstrated to be economically sound. Therefore, emphasis throughout the author's tour of duty was on promoting the intensive culture of fish, especially in the State of Ceara in Brazil's Northeast. Intensive fishculture was nearly nonexistent in the Northeast, with the State of Ceara having none 2 years ago.

Strategy

By June 1973, results of experiments indicated that culture of the all-male *Tilapia* hybrid – produced by crossing the male *Tilapia hornorum* and female *Tilapia nilotica* – was promising enough to be recommended for private use through an extension program. DNOCS publicized this method of culturing *Tilapia* through the television and newspaper media. This method of disseminating information continues to make both technical and non-technical information accessible to fish farmers and potential fish farmers as well.

Crossing the female Tilapia nilotica (top) and the male Tilapia hornorum (center) produces an all-male Tilapia hybrid offspring (bottom).

As interest has increased, farmers have begun to contact the DNOCS fishculture extension service. Each interested farmer is then visited. His land area is examined and a determination made on its potential for intensive fishculture on a commercial scale or non-intensive fishculture on a subsistence level. If needed, assistance is given in outlining projects for obtaining loans, or to demonstrate to the farmer how his investment could be most economically applied.

One of the most effective means of extension is through demonstration. To create interest in any new farming enterprise, however, the demonstrations must indicate economic success and establish that the program lies within the investment and technical capacity of the prospective farmer. The DNOCS extension service is implementing intensive fishculture demonstration projects on private farms that offer good possibilities for success. These projects are given close supervision by DNOCS personnel.

The first of these private farm demonstration units will be ready for harvest in August 1974. Based on excellent results at the research station, good yields are expected, which should encourage more cautious farmers to enter the intensive fishculture program.

Private Farms

During the first year, the DNOCS extension service visited approximately 25 private farms to evaluate their potential for intensive fishculture. Of these 25 farms, which range in size from a few hectares to thousands of hectares, three have begun fishculture – two in the county of Maranguape, Ceara State, and one in the county of Tutoia, Maranhao State. Several other projects are in initial stages of implementation, all in Ceara State.

The all-male *Tilapia* hybrid is thought to be the ideal fish for culture in this area. This cross is being recommended in most instances. The farmers involved have not yet gained sufficient experience to produce their own crosses, however, and must rely on DNOCS to supply their fingerlings.

Farmers whose land is isolated by distance and/or bad roads from the DNOCS station are being encouraged to produce pure stocks of *T. nilotica* and taught to divide them by sexes when they are large enough to sex. Each sex is then used in mono-sex culture.

Efforts in the extension program have been concentrated primarily in the Marangnape area where there are many conditions favorable for fish culture: (1) soils suitable for pond construction, (2) an ample water supply, (3) proximity to the city of Fortaleza, and (4) relatively high farmer interest.

The two fishculture projects in Maranguape are owned by large farmers who are seeking new crops to diversify their dairy enterprises and to take advantage of unproductive lowlands. The first farm (Fazenda Jaramataia) began with three ponds having a combined surface area of 2 hectares. Unfortunately, extremely heavy rains broke the dam of a large reservoir immediately above these three ponds. One pond that was ready to be harvested was destroyed. The remaining two were not damaged and will be stocked with fish after the large reservoir is repaired. All three production ponds were built by damming natural depressions in the land, leaving the pond margins in their natural state and avoiding high excavation costs. Therefore, with good fish husbandry a high rate of return can be expected in a relatively short time. This type of pond construction is being encouraged wherever topography permits.

Prior to destruction of the first pond, seining samples

Top: A 6,000-square-meter, semi-natural fishpond on the "Fazenda Jaramataia" with reservoir in background. Bottom: Inexpensive dam used to flood semi-natural fish ponds. The low investment costs result in higher profits for fish farmers.

showed that 300 *Tilapia* sp., 1,050 *Tilapia nilotica* males, and 300 Israeli carp weighed approximately 690 kilograms, an increase of 515 kilograms from the stocking weight of 85 kilograms. Projecting these growth rates, fish production per hectare would have been approximately 1,000 kilograms in 4 months. The pond was enriched with 100 kilograms of triple superphosphate in two weekly applications before stocking fish, and during the culture period chicken manure was applied bi-weekly at 830 kilograms per hectare.

Many farmers in Maranguape followed the progress on the Fazenda Jaramataia with interest. Even though measurements of final results were not possible, samples that were taken indicated that fishculture would probably have been profitable.

Convinced of fishculture's viability, a neighboring farmer of the Fazenda Passagem Franca began pond construction in February 1974. This project also utilized an unproductive natural lowland below a reservoir by building a small dam to form a pond with natural margins. This pond covers an area of 8,000 square meters.

Water was siphoned from the reservoir to fill the pond. Seepage through the reservoir dam is sufficient to maintain the pond water level. A harvest basin was excavated near the drain to facilitate harvest.

Approximately 8,000 *Tilapia* hybrids (10,000 per hectare) were stocked in the pond in early April 1974. Fish are being fed a moist wheat bran feed once daily, 7 days per week at a calculated rate of 4 percent of the standing crop of fish. In addition, small quantities of inorganic fertilizers and animal manure are being periodically applied to the ponds.

Feeding rates are adjusted each month by taking fish samples to measure weight gain. The average weight gain per fish during the first 2 months was 98 grams. Food conversion averaged less than 2:1[4].

After approximately 4 months' growth, the hybrids should average 200 grams. Harvesting will begin at that time and is expected to be completed in a period of approximately 1 month. Most of the fish will be marketed in the town of Maranguape, which is 10 kilometers away. If retail prices for fish remain about the same (Cr$4.00[5] to Cr$5.00 per kilogram in Maranguape) in 1 year this farmer will have recovered his investment of Cr$4,000, paid operating costs, and realized a profit.

Many farmers in the Maranguape area are awaiting the results of the harvest. If convinced that intensive fishculture can be profitable, many of them are expected to begin culturing fish on their own farms. Area farmers, bankers, and television and newspaper journalists will be invited to watch the first harvest at the Fazenda Passagem Franca.

Fingerling Supply

At present, *Tilapia* hybrid fingerlings are being produced at the Pentecoste, Ceara, Intensive Fishculture Research Station, and at the fish hatchery Waldemar Franca in Maranguape, Ceara. The fingerlings from Pentecoste are used primarily in research and those from Waldemar Franca for reservoir stocking. However, a portion of the fingerlings from each station are being distributed free to certain landowners as an incentive to begin the private culture of fish.

Growing interest in fish production will push annual demand for fingerlings much beyond the capacity of both stations (20,000 fingerlings per hectare required annually). Therefore, to make adequate stocks of fingerlings available will require expanding the breeding program to other DNOCS hatcheries, construction of additional public hatcheries, commercial fingerling production by private enterpreneurs, or training the fish farmers themselves to maintain and crossbreed genetically pure species of *Tilapia*. Although the latter method would probably be the better final solution, it must be implemented with caution to prevent mongrelization which would reduce the chances of producing all-male offspring.

DNOCS Irrigation Projects

In the Northeast there are 117 large reservoirs (of 2 million cubic feet or more) under the responsibility of DNOCS. Within the past 5 years DNOCS has embarked on a vigorous plan of fully utilizing the water resources of these reservoirs by building irrigation systems in the low, flat valleys situated below the dams. In each valley where studies show that irrigation is a feasible undertaking, land is appropriated, cleared, and improved by building irrigation canals and drain-

[4] Dry weight of supplemental feed per unit of fish weight gain.
[5] U.S. $1.00 = Cr$6.68.

Dam and 8,000-square-meter fish pond on the "Fazenda Passagem Franca." Total annual fish production should be about 4,500 kilograms, worth more than Cr$18,000 at present retail prices (U.S. $1.00 -- Cr$6.68).

age systems. Then, after a process of selection, small peasant farmers are given a house to live in and 5-hectare plots of land to cultivate under the supervision of DNOCS agronomists.

According to economic studies done in collaboration with the DNOCS Directorate of Fisheries and Fisheculture, the incorporation of fisheculture in these projects would add considerably to the colonist's income. This has been in the planning stages since 1972.

With the help of Dr. J. E. Greenfield, short-term consultant under this contract, an economic feasibility study was elaborated for intensive fisheculture in DNOCS irrigation projects. Also, the extension service published a simple but comprehensive fisheculture manual for use by colonist fish farmers. DNOCS received financial help from SUBIN[6] SUDENE to fund the implantation of fisheculture in irrigation projects.

At the time of this report, areas had been chosen on which to begin construction of the first ponds that will be managed jointly by several colonist farmers, who will divide the profits. If successful, the role of fisheculture in the irrigation projects will be expanded, perhaps including a small fish hatchery on each project for *Tilapia* hybrid fingerling production. Extension workers will make every effort to ensure the success of intensive fisheculture in DNOCS irrigation projects, but additional extensionists will undoubtedly be required.

[6] Sub-office for International Economics and Cooperation.

With initial success, a colonization irrigation project based entirely on fisheculture may be a possibility. In this case a DNOCS reservoir would be chosen with a valley below that is suited to fisheculture but which does not offer soil and water conditions suitable for terrestrial crops.

This possibility will be investigated during the author's tour under another technical assistance contract from July 1974 to July 1975.

Economic Study

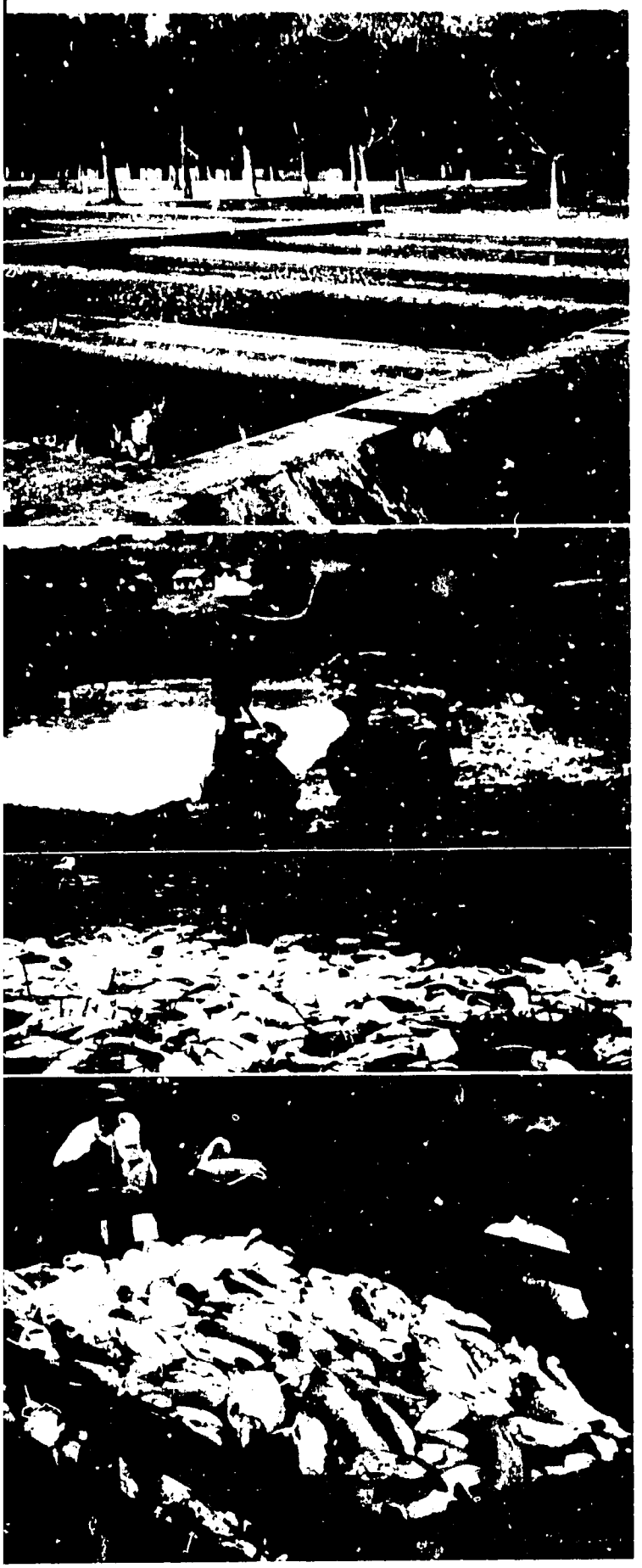
Dr. Greenfield, regional economist of the National Marine Fisheries Service, was brought to Brazil under the present contract to assist in an economic feasibility study for the intensive culture of the *Tilapia* hybrids in the Northeast with special attention to DNOCS irrigation projects. The table is a profit and loss statement elaborated by the consultant and the DNOCS fisheries economist for culturing 1 hectare of fish (10,000 fingerlings) on a DNOCS irrigation project. Return on total investment is projected at 34 percent.

PROFIT AND LOSS STATEMENT FOR *Tilapia* HYBRID CULTURE ON DNOCS IRRIGATION PROJECTS

Item	11-month production cycle	Annual basis
Fixed cost		
DNOCS administrative surcharge	Cr$ 102	Cr$ 111
Pond and gear maintenance	321	350
Amortization, real estate	1,388	1,514
Amortization, equipment	103	112
Total fixed cost	Cr$ 1,914	Cr$ 2,087
Variable cost		
Feed	Cr$ 4,476	Cr$ 4,883
Fertilizer	920	995
Water	571	623
Fingerlings	540	589
Interest on working capital	146	159
Operator's labor	286	312
Hired harvesting labor	42	46
Hired pond bottom maintenance labor	35	38
Hauling and marketing expense	117	128
Miscellaneous and contingencies	220	240
Total variable cost	Cr$ 7,253	Cr$ 7,913
Total cost	Cr$ 9,167	Cr$10,000
Total income (3,813 kg. @ Cr$3.60/kg.)	Cr$13,726	Cr$14,974
Profit	Cr$ 4,559	Cr$ 4,974

Fishculture Manual

As a teaching tool and a means of disseminating the results of DNOCS fisheculture research, a simple but comprehensive manual giving instruction in the intensive culture of the *Tilapia* hybrid was published in 1974 with funds from SUDENE SUBIN. This manual, "Cartilha do Criador de Peixe," is directed toward the low educational level of most small farmers. Numerous drawings, photographs, and simple tables are designed to help an inexperienced reader understand the text. Although of a simple nature, the manual gives details on pond construction, feeding, fertilizing, and economics that should be useful to farmers of all educational levels. This manual should be one of the more useful teaching devices used in training colonists in fisheculture on the DNOCS irrigation projects.



Top: Tilapia hybrid production tanks located at DNOCS Waldemar de Franca fish hatchery in Maranguape, Ceara. Area of each tank 36 square meters. Center: Harvest of 7-hectare pond located in the Sao Francisco River Valley. Bottom: Results of a harvest. Annual profit reached Cr$2,466 per hectare for this farmer.

Sao Francisco River Fishculture

Two trips were made by the author to the lower Sao Francisco River Valley in the Penedo Region to observe existing fishculture operations on local farms. Fishculture was begun in this region approximately 9 years ago by 1 farmer and now includes at least 10 others.

Lakes lateral to the margins of the Sao Francisco River are often utilized as ponds by controlling the entrance and exit of water with gates constructed in the waterway linking the lake to the river. Other ponds are constructed in small watersheds using runoff or small permanent streams for water supplies.

Three species of fish are cultured: the curimata pacu (*Prochilodus argenteus*), mandi amarelo (*Pimelodus clarias*), and piau verdadeiro (*Leporinus* sp.). Of these three, the curimata pacu makes up 80 percent of total fish production from these ponds.

Fishculture systems are poorly developed due to lack of technical know-how. Stocking rates are low (900 fish per hectare), supplemental feeding is almost non-existent, and fertilizers (either organic or inorganic) are only used occasionally. All present methods have been learned through trial and error.

Although the methods are rudimentary, profits are impressive, mainly because of the high price for which fish are sold on the local market and the comparatively low cost of production. Demand is high throughout the year but demand as well as prices increase during the Easter Week because Roman Catholic tradition requires the eating of fish during this entire week and the population is heavily Catholic. Most fish farmers therefore harvest during Easter Week. In 1974, the largest regional fish farmer harvested 22 hectares of ponds during Easter and realized a net profit of Cr$2,466 per hectare for the year.

Fishculture in the lower Sao Francisco River Valley is unique in Brazil. Learning modern fishculture techniques would be greatly beneficial to farmers of the area. Although DNOCS is interested in working with fish farmers in this area, it has no direct authority because the Penedo Region is not within its jurisdiction. DNOCS could assist fish farmers in the Penedo Region by offering intensive fishculture training to regional agricultural extensionists who, in turn, could keep the fish farmers abreast of new methods as they are developed by DNOCS researchers. A great fishculture potential exists in the Lower Sao Francisco River Valley and should not be left undeveloped for lack of trained technical assistance.

MANAGEMENT OF SMALL, NATURAL IMPOUNDMENTS FOR PRODUCTION OF FISH

The culture of fish on an intensive basis is expected to improve the economy of involved farmers and workers, and to provide a source of high protein food at a price most wage earners and tradespeople can afford. Such a program is badly needed because a large segment of the population of the Northeast exists at a subsistence level. Almost all of their

food and other needs are produced by themselves on small plots of land on which they live. Fish, at whatever low price, are completely beyond their means. The DNOCS fisheulture extension service has initiated a program to increase the production of fish in small natural impoundments in an effort to alleviate the plight of these people.

The objective of this program is to provide animal protein at almost no cost by utilizing small bodies of water (both permanent and temporary) found throughout the Northeast. These bodies of water, often small reservoirs, borrow pits, or ponds, have always provided a small quantity of fish to rural populations. Regional fish species, mostly traira (*Hoplias malabaricus*), acara comum (*Cichlasoma bimaculatum*), and piaba (*Astyanax* sp.) enter these ponds during the rainy seasons when they overflow into temporary rivers. These fish are captured by the villagers usually during the dry season. At this time of year their diets are the most deficient in staple foods and the fish, therefore, are an important resource.

To increase the fish production of these waters, a stocking program was initiated using three *Tilapia* species: *Tilapia nilotica*, *Tilapia hornorum*, and *Tilapia rendalli*. Tilapias were chosen for stocking because it was thought that their growth in temporary ponds (those that hold water for at least 4 months of the year) would be sufficient to compensate for the Government's expense of yearly stockings. In more permanent ponds, or those that dry up only in drought years, it was believed that *Tilapia* would fill grazing niches not already filled by native fish species, thereby increasing production. *Tilapia* offspring would also provide natural food for carnivorous fish such as traira.

To test this hypothesis two small reservoirs were chosen for stocking, one less than 3 hectares in surface area located in Umirim, Ceara, and one approximately 7 hectares in size in Croata, Ceara. Both communities in which the reservoirs are located have populations estimated to be 2,500, the majority of which are subsistence farmers.

The Umirim reservoir is considered permanent since the last time it dried was in 1958. The existing fish population is composed of those native species already mentioned. The reservoir in Croata is considered to be a temporary reservoir because it dried completely in 1972 and in many previous years. No native fish populations were found in Croata reservoir at the time *Tilapia* were stocked.

Before stocking *Tilapia* and initiating a creel census, samples were taken from the Umirim reservoir to estimate the standing crop of fish. Four sections with known surface areas were chosen and, during the night, gill nets of 3-centimeter stretch mesh were set to prevent the escape of fish within the area. The following morning seines were used to capture fish trapped within each area. Fish seined and gill netted inside the areas were measured, counted, and weighed. A standing crop of 35 kilograms per hectare was the average found from these four areas.

In late 1972 *Tilapia hornorum* were stocked in Umirim reservoir at a density of 500 per hectare, and *T. nilotica* at 300 per hectare were added in 1973. Fishing was suspended until April 1973 then fishing was allowed and a creel census initiated. Records were made by species, weights, and capture methods over a 1-year period. In this way, both total harvest and changes in species composition were followed closely. As an incentive to report catches, free hooks and line were given for each reported catch. Fishermen participation was excellent, thus the census is considered to be highly accurate.

For the 1-year period beginning in April 1973, total production was 1,474 kilograms, or 592 kilograms per hectare per year, with most of the catch made between April 1973 and January 1974. Heavy rains in the last few months (January-April) interfered with fishermen efforts and reduced the catch. In addition, food from other crops is abundant at this time of year, and the incentive for people to fish decreases. *Tilapia* made up 7.9 percent of the total production, or 46 kilograms per hectare per year.

Rural families supplement meager diets by eating fish captured in drying borrow pits and small ponds. Boys fish with "choqus" or thrust baskets.

In early 1973, *Tilapia rendalli*, *Tilapia hornorum*, and *Tilapia nilotica* were stocked in Croata reservoir. This was during the rainy season and the water was rising. A creel census was begun in July 1973. *Tilapia rendalli* appeared much more frequently in the catch than *Tilapia hornorum*. Through 1973, total *Tilapia* production reached 430 kilograms or 120 kilograms per hectare per year, but began falling off sharply as heavy rains caused a decrease in fishing pressure. The total production figure recorded for a full year in Croata reservoir will not be as accurate as that recorded for Umirim reservoir because the former is difficult to supervise due to its larger size. The Croata fishermen were also less cooperative in reporting catches than those at Umirim.

Though the final data are not in from Croata, the benefit of a fisheulture project such as this is evident. In two small bodies of water over 1,400 kilograms of fish were harvested

No fish is too small for this group of young fishermen who display their catch.

during the year, mostly during the dry season. There are hundreds of thousands of similar bodies of water in the Northeast. If many or most of these were managed similarly, a significant amount of fish protein could be produced each year. Even a limited program of stocking these waters could have considerable impact on the diet of the rural poor.

A continued DNOCS effort in this area would be well compensated and the Brazilian Federal Government through SUDEPE[7] has recognized the importance of the program by granting money to DNOCS (Cr$300,000) for research.

COUNTERPART TRAINING

One of the more important needs in a development program such as the one under discussion is training personnel to continue the project when the initial technical assistance is terminated. These trained counterparts should be capable of carrying on the work in progress and of providing motivation and innovation necessary for continued development.

DNOCS did not have a biologist trained in fisheulture extension when this contract began. Such a position has been created, however, and filled with a biologist trained in intensive fisheulture. This biologist is not only well qualified in the position, he is highly motivated and able to communicate well with rural farmers, translating technical information into a terminology easily understood by them.

In recent months, farmer interest in fisheulture has increased to the extent that the workload is too great for one person. At this time, however, DNOCS is not in a position to add personnel because the Federal Government has suspended hiring.

After unsuccessful efforts were made to secure additional extension workers by agreement with other Federal and State agencies, DNOCS assigned part-time extension duties to two fish hatchery staff members. Their duties will be to provide technical assistance and to maintain production and financial records after feasibility studies, pond construction, and initial stocking of fish has been completed under the supervision of the full-time extension worker from the Fisheries Research Center in Fortaleza.

This arrangement is only a temporary solution to on-farm fisheulture assistance at best. A new 1-year contract for extension work will begin in July 1974 to provide continuity to the present program. Under this agreement, additional extension workers will be trained. In time, DNOCS plans a thoroughly trained extension service providing assistance in fisheulture.

[7] Superintendencia para o Desenvolvimento da Pesca (Superintendency for the Development of Fisheries).

CONCLUSIONS AND RECOMMENDATIONS

Technical assistance rendered under the Auburn University Brazil Contract, AID csd-2270, Task Order No. 8, provided the initial impetus and training for forming an extension service for intensive fishculture within the DNOCS Directorate of Fisheries and Fishculture. This program put research results to practical use in intensive fishculture, which was introduced for the first time to farms in Northeast Brazil. Also, training personnel in basic extension methods was a major accomplishment during the present contract.

For continued progress in forming an extension service capable of satisfying the needs of farmers and for systematic development of intensive fishculture to its fullest possibilities, the following recommendations are presented:

Extension Personnel

Expansion of intensive fishculture will require more trained extensionists to provide the necessary technical assistance that farmers will need. Perhaps through agreements with the state agricultural extension services, DNOCS will be able to meet this manpower requirement. Other possibilities include interagency agreements providing for the transfer of personnel from the State Secretary of Agriculture to DNOCS, which has been done before, or by assigning current DNOCS employees to extension work.

New extension workers from whatever source will require up to a year's training in fishculture and extension work. Personnel chosen should be those who appear to be motivated for this type work and sensitive to the problems of the people they are to assist.

In view of the greatly increased workload that is expected in fisheries extension, DNOCS should begin its training program as soon as possible.

Fingerling Supply

To date, DNOCS has had no problem providing sufficient numbers of fingerlings to the few farmers involved. Within perhaps 2 years, however, the presently existing DNOCS fish hatcheries will not have the capacity to supply the fingerlings that will be required.

To prepare for future fingerling requests, DNOCS should initiate fingerling production in all hatcheries in areas where intensive fishculture is to be introduced, increase the fingerling production capacity of all hatcheries by constructing more spawning ponds, and authorize fingerling production by a selected few private farmers or firms. The last method should provide the most important permanent source of hybrid fingerlings in the years ahead.