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The nine states composing the northeast Brazil represent about 19 per cent of the total area of Brazil but contains 30 per cent of the country's total population. Though Brazil is in a phase of rapid industrial expansion and development that is being called an "economic miracle", the Northeast has yet to be touched by this miracle in a serious way.

Since 1940, the population of the Northeast has more than doubled, increasing from 14 million to 28.3 million in 1970. The present population growth rate is estimated at about 2.9 per cent annually. Approximately, 60 per cent of the population is in rural areas, and the vast majority are share-croppers or renters.

Per capita income in the Northeast in 1955 was $127. By 1970, this had increased to nearly $200. However, the average income for the rural population has not changed and is still around $60 per year.

The Northeast is also plagued with a semi-arid climate characterized by periodic droughts that does not allow crops to be planted outside the short rainy season without irrigation. Droughts in 1950 and 1958 resulted in the loss of thousands of head of livestock and caused severe hardship on the inhabitants of the region. Even when sufficient rain falls during the four-

month rainy season (February - May) to allow the people of the interior to plant and harvest their crops of corn, beans, and manioc, malnutrition and lack of protein are still a constant threat. The daily per capita caloric intake in the Northeast was estimated to be 1,940 in 1971. World health authorities consider a daily caloric intake of 2,500 the minimum necessary for adults.

Though it seems strange in such an arid land, fish play a major and sometimes crucial role in the diet of the inhabitants of the Northeast's interior. In the early 1900's, the Brazilian Government established the National Department of Works against Droughts (DNOCS) to help deal with drought problems. DNOCS subsequently constructed or assisted in the construction of nearly 6,000 ponds and reservoirs in the Northeast that offer potential for irrigation and fisheries development. The Northeast also contains many thousands of small private ponds that are capable of producing annual crops of fish. These ponds and reservoirs trap and hold runoff water that falls during the rainy season. The people have traditionally fished these waters in order to supplement their food supply.

In 1962, the officials in charge of the DNOCS fisheries program became concerned over an apparent drop in reservoir fish production and requested the assistance of the Agency for International Development (USAID) to survey the problem and suggest possible solutions. As a result of a preliminary survey in 1966, USAID, DNOCS and SUDENE (Superintendency of Development of the Northeast) contracted with USAID to assist in the creation of a major fishery research center located at Fortaleza in the Northeast state of Ceara. In 1968, a USAID contract with Auburn University's International Center for

Aquaculture tied the fisheries project into the Center's international research network.

The Fresh-Water Fishery Development Project, as the Research Center came to be known, has two goals: (1) to increase the supplies of animal protein for the people of the Northeast who fish the ponds and reservoirs, and (2) to develop aquaculture technology to permit the establishment of commercial fresh-water fishculture as an industry. Both objectives are important to the development of the Northeast and, in the long run, Brazil.

From this modest beginning in 1966, the Research Center has become one of the best equipped and staffed facilities of its kind in South America. Currently the project has a staff of 30, of whom 12 are professional biologists. Of the 12 biologists, 8 have received training in the United States in the disciplines of fishery biology, limnology, fish technology, and fishculture. Auburn University has supplied technical assistance in the areas of reservoir management and fishculture. Presently, the senior author and Mr. John Jensen are providing technical services in intensive fishculture and extension.

Along with a well-equipped laboratory and offices in Fortaleza, the largest freshwater fishculture research station in South America was built 85 kilometers west of Fortaleza in the interior of Ceara near the city of Pentecoste. The research station consists of 56 earthen ponds ranging in size from 0.1 to 1.25 acres, 10 concrete sided tanks each with a surface area of 400 square feet, wet lab, feed house with a small pelleting machine and 8 concrete holding tanks. Work has started on a companion research station located 1 mile from the existing station. The completion of 48, 0.1-acre and 8, 1.25-

acre earthen ponds is expected in early 1974, which will give the Research Center a combined total of 112 earthen ponds containing 36.2 acres of water. The combined research facilities will be one of the largest and best equipped of its kind in all the tropical world and will act as a center for fishculture

Research activities at Pentecoste have been centered on evaluating exotic fishes for possible introduction into reservoirs to increase production, evaluating the fishculture potential of several Brazilian fishes and developing improved culture systems for already established cultured fishes.

Brazil possesses a wealth of fish species, many of which could be well suited to raising in ponds or stocking into reservoirs. The Amazon River basin alone is reported to have 1,300 species of fish of which 507 are catfishes. By comparison, the Mississippi River basin has only 250 known species of which about 20 are catfishes. Thus, many years of work will be needed to capture, transport, acclimatize and evaluate those tropical fish species with culture potential.

Two species of fish from the Amazon River that have shown excellent culture potential in preliminary pond tests are Tambaqui, Colossoma bidens; and Pirapitinga, Mylossoma bidens. Tambaqui stocked at 840 per acre with an average weight of 6 g resulted in a total production of 2,235 lb per acre over a 13-month period. At harvest, the tambaqui had an average weight of 2.7 lb. The fish were fed a pelleted ration containing 29.1% protein of which 8% was of animal origin. Tambaqui received feed at 3% of their body weight per day, 6 days a week. The conversion rate over the experimental period was 3.1 to 1.

Tambaqui readily accepted pelleted feed and proved to be able to withstand low dissolved oxygen levels for long periods of time by gulping air at the water surface. The fish is easy to handle as it has no sharp spines or fin rays and is the easiest fish to capture with a seine that the authors have ever worked with. Two men pulling a standard bag seine in a full pond can capture 90 to 100% of the fish in the pond with one haul. The fish neither jumps nor lies in the bottom mud to escape the net but remains in a closely bunched school in midwater. Tambaqui may prove to be a valuable fish in polycultures as it is a filter feeder. Stomach analysis has shown that tambaqui feeds almost totally on zooplankton in culture ponds in the absence of a ration.

Pirapitinga, a close relative of tambaqui, stocked at 1,065 per acre with an average weight of 9 g resulted in a total production of 2,202 lb per acre over a 13-month period. At harvest, pirapitinga had an average weight of 2.2 lb. The fish were fed the same pelleted ration at the same rate as tambaqui. Rate of conversion for the 13-month period was 3.38 to 1.

Pirapitinga proved to be equal to the tambaqui in acceptance of a pelleted ration, resistance to low dissolved oxygen and ease of handling and capture with a seine. Both are readily accepted at the market.

Stomach analysis demonstrated that in the absence of a ration, pirapitinga is an omnivore, feeding on shrimps, aquatic insects and seeds and fruits from land plants. In the Amazon River, pirapitinga and tambaqui are known to feed on fruits and seeds from terrestrial plants when these are

available. The authors have fed pirapitinga a wide variety of fruits and vegetables including fresh corn, beans, pieces of cucumbers, bananas, and watermelon which were readily accepted skin, rind and all.

At present, the major problem concerning the pirapitinga and tambaqui is the lack of knowledge concerning their reproductive behavior. It is not presently known if these fishes can be spawned under culture conditions so further information concerning the culture potential of these fishes will have to await sexually mature fish for spawning tests.

In an effort to bring fishculture to the Northeast, the authors are conducting field tests with exotic cultured fishes so the improved culture systems can be introduced to the farmers of the region through the DNOCS extension program. Tilapias and mirror carp are gaining the most attention as these species present the most immediate culture potential.

Tilapias are raised in many tropical regions around the world. Tilapias have the advantages of feeding low on the food chain (i.e. plankton), being extremely resistant to poor water quality and growing extremely well when fed on a wide variety of cheap agricultural waste products. The major drawback to raising tilapias is their excessive reproduction in culture ponds that results in a large percentage of undersized fish and very few fish of marketable size.

To control reproduction of Tilapia nilotica in ponds, the authors are testing the stocking of local predator species with T. nilotica and the monosex culture of male T. nilotica. However, the most effective methods of eliminating unwanted reproduction is the technique of producing all male Tilapia hybrids.

The authors obtained two species of Tilapia (T. nilotica and T. hornorum) from Ivory Coast, Africa. When the male T. hornorum is placed with the female T. nilotica they naturally hybridize, producing offspring that are 100% males in every case. The male hybrids can then be stocked without fear of reproduction as long as no females are accidentally introduced into the ponds. The hybrids exhibit hybrid vigor, outgrowing either parent species.

In experiments, Tilapia hybrids with an average weight of 7 g and stocked at 3,640 per acre resulted in a total production of 912 lb per acre and 1,584 lb per acre with organic fertilization and feeding respectively during a growing period of 253 days. The average weight of the fish produced was .3 lb with fertilization and .5 with feeding. The feed utilized was a mixture of 50% wheat chafe and 50% castorbean meal fed as a moist feed ball. The rate of conversion was 2.7 to 1.

The authors are now investigating various methods of increasing production of fish in ponds. One of the most promising appears to be the polyculture of two or more species of fish in the same pond. Now being tested is the polyculture of Tilapia hybrids and mirror carp. Future experiments will evaluate grass carp, Ctenopharyngodon idella, and silver carp, Hypophthalmichthys molitrix raised in combination with the above two species.

DNOCS, with the help of USAID and Auburn University, has established a solid research center with which to pass on tested systems of fishculture to the farmers of the Northeast and possibly to other countries of Latin and Central America. Research has shown that fish can be cultured economically

providing economic benefits to the farmers as well as providing a cheap source of high-quality protein for the people. The potential for fishculture in the Northeast is great and DNOCS feels that the future will demonstrate that fishculture will play a role in bringing the "economic miracle" to northeast Brazil.