Pitfalls in Third World Aquaculture Development

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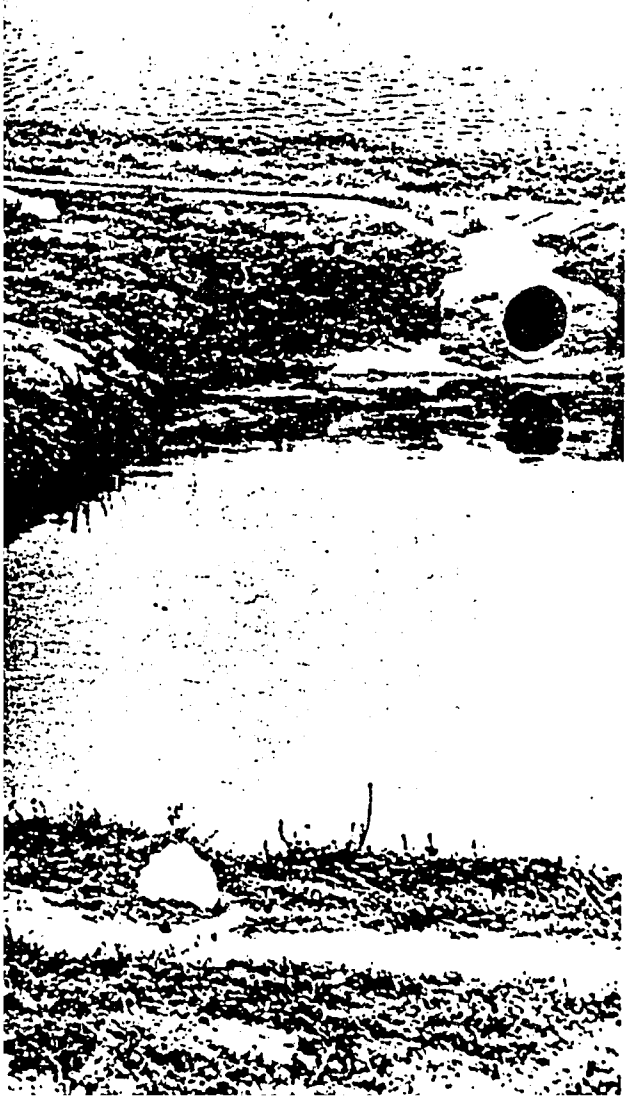


Aquaculture — raising marine or freshwater animals and plants in controlled environments — has been suggested as a partial solution to world food problems. Development projects in the Third World have been supported by international, national, and private agencies interested in improving the quality and quantity of food throughout the world. Some of these projects have failed: some because of inadequate attention to social, economic, and political factors; others because of inadequate understanding of the mechanics of fish culture. Learning from these mistakes, developers of Third World aquaculture can plan future projects more carefully.

Variations and Constraints

There are as many variations in techniques for fish farming as there are for growing other crops. Each fish farmer must decide on a crop appropriate to his region, land, and market, and then prepare the pond, procure seed, introduce fish, add nutrients, harvest, process, and sell or distribute the crop. Fish farmers are constrained by seasonal changes, weather, disease, predation, and the lack of materials, capital, parts for machines, trained labor, or management experience. They also may be affected by other local food-producing sectors, such as agriculture and capture fisheries. Furthermore, local, regional, or national governments may be responsible for constraints in the form of laws, lack of educational or training

Freshwater fish farm at Chapingo, Mexico. (Photo courtesy of FAO)

Placing spawning beds in ponds (left) at a fish farm in Chapingo, near Mexico City. This project is run by the Mexican government. Carp in these ponds can be harvested with nets (right). (Photos courtesy of FAO)

facilities, inefficient capital flow, poor transportation facilities, or inadequate marketing systems.

An individual, family, cooperative, or large business may operate a fish farm, using an artificial environment (a newly dug pond, an irrigation system adapted to aquaculture, a concrete tank) or a natural one (an existing pond, bay, or protected waterway). A freshwater system may require adapting land use from agriculture or irrigation. In the Far East, fish of the genus Tilapia are grown in rice fields, where the fish and the rice are harvested simultaneously. An attempt to transplant this practice to Egypt failed, however, primarily because the rice-growing season there is shorter. When the Egyptian rice fields were drained for harvesting, the Tilapia had only just reached their breeding period.

Brackish and saltwater aquaculture will not necessarily disrupt or displace traditional agriculture but may affect traditional fishing, seaweed harvesting, or other uses of bays, estuaries, mangrove swamps, or shallow-water areas. Floating cages, raft systems, elaborate net enclosures, and other structures may be used to keep fish or shellfish within the control of the farmer but may demand accommodation by other users of the area, who may be accustomed to unregulated harvesting or unrestricted passage.

Regardless of the physical setting, aquaculture production requires a source of broodstock or seed, nutrients, good water quality, and the means of controlling predators and disease. In addition to raw materials, engineering and biological knowledge are necessary to design and operate the system.

Cultured fish are harvested in several ways. In artificial enclosures or ponds, fish are "herded" to one end of an enclosure and then netted, or the ponds are drained. In open systems, fish or shellfish may be grown in racks, from rafts, or in cages that can be pulled or harvested periodically. Aquaculture harvesting techniques have definite marketing advantages over capture fishing. For example, draining a pond produces predictable quantities of fish at one time, and periodic harvesting allows for appropriate timing of deliveries to the market and distribution of income or protein on a regular basis.

Aquaculture products can be prepared in several ways. If fish are destined for sale near the production site, they can be sold fresh whole or may be gutted, gilled, or headed before being chilled and sent to market. In areas where the growing site is some distance from market, fish may be chilled on ice, frozen, salted, smoked, or dried. The processing technique need not be elaborate; in many places such processing is done by women, old men, or adolescent children, with minimal capital equipment. For new products, special marketing studies or promotion campaigns may be needed.

Aquaculture may compete with other production systems on several levels. Supplies of labor, space, capital equipment, and financing can be drawn from a common pool. Competition for facilities is likely to be most severe at the local and regional level, although production destined for a

distant urban or export market may encounter critical shortages or congestion in other parts of the economic system. Even if there is no immediate physical conflict with capture fisheries over the use of ponds or brackish water inlets, conflicting ownership claims are likely to arise if the aquaculture activities add value to property. The cultured product is in direct competition with fish or shellfish harvested from the wild, and in less direct competition with other foods, particularly those high in protein. Transportation and marketing systems are generally used by producers of all food items, as well as by other production sectors of the economy.

The circumstances and perceived needs that lead to the development of aquaculture may change over time. An aquaculture project may be a temporary solution to local problems but may not be viable over the long run. Viability depends not only on economic profitability but also on the role the project plays in the community. Customs and traditional power structures are likely to be more important than written laws in determining how an aquaculture enterprise operates. Customs ranging from socially accepted pilfering to traditional labor roles for segments of the community will influence the organization and operation of any project.

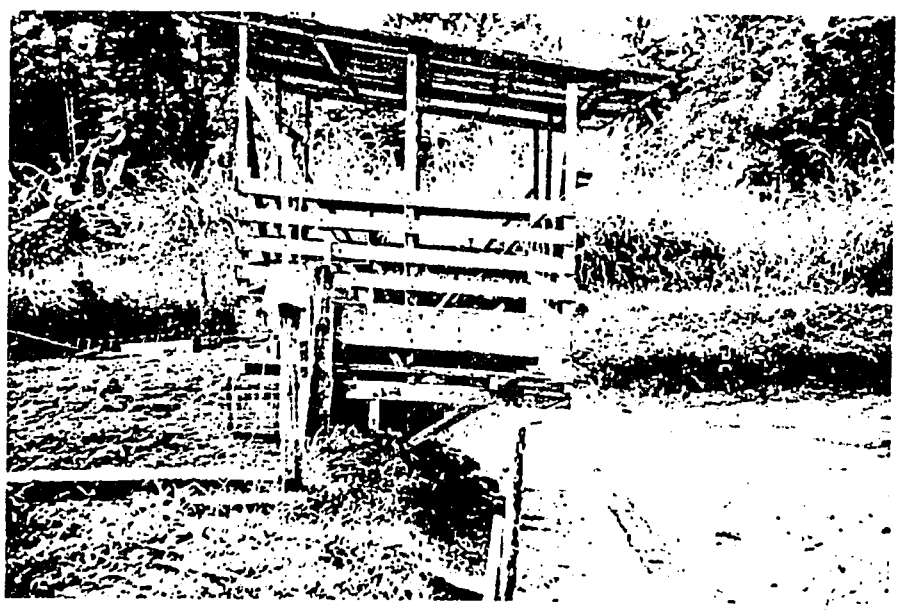
Where the regional government is responsible for the maintenance of roads and communication systems, the operation of extension services, hatcheries, and other facilities can be organized on a regional or national basis. National governments determine the formal structure of laws and regulations, and national development plans may be critical for encouraging or discouraging aquaculture relative to other activities. Other policies — such as differential exchange rates, provision of credit facilities, educational systems, participation in regional trade groups or activities sponsored by international agencies, and the economic and technological infrastructure — are important considerations in development planning.

Problems

A major goal of food development programs is to improve the nutritional well-being of the population. Another goal is to increase local income levels with the assumption that people will use this increased income to improve their standard of living — better food, medicine, education, and housing. However, people sometimes spend the increased income on products or activities considered frivolous or nonproductive by the planners.

In the choice of growing, harvesting, and processing techniques, the needs of the community should be considered. For example, in regions with high levels of unemployment, a labor-intensive technology might be selected despite the fact that it is neither biologically nor economically the most efficient from a business standpoint. Conversely, if some sectors of the population are suffering severe protein shortages, a technology that produces the largest volume of fish in the shortest period of time may be selected, with other means developed to address the unemployment problem.

In some developing countries, labor may be so abundant that the marginal productivity of labor in agriculture or fishing is near zero: taking away some workers from traditional activities and putting them to work on aquaculture may not decrease productivity in the rest of the local economy. In



This pigpen feeding area was deliberately built on the edge of an aquaculture pond on a farm in Costa Rica's Limón province. The floor is slanted so manure that falls there can be scraped or washed easily into the pond, supplying nutrients. However, too much manure causes an overabundance of microorganisms, which reduce the growth rate of the fish by lowering the pond's oxygen content. In this case, the pond has just been drained. Considered too nutrient-rich for a new crop of fish, the pond was planted with water spinach. (Photo by Bob Mack, New Alchemy Institute)

Small fish ponds near dwellings like these in the "atomistic" town of Teacapan, Mexico, could help families through periodic food shortages. (Photos by J. R. McGoodwin)

other situations, however, the amount produced by labor in the new aquaculture project must be assessed in terms of loss of productivity from other activities. For example, in a Philippine community the change from capture fishing to seaweed farming resulted in a decline in fresh fish landings. The scarcity of fish contributed to a tripling of local fish prices over a year.

In some areas, farmers may be unwilling to deal with fish, while a traditional fisherman may feel that aquaculture is a form of farming and that engaging in it would damage his image. Another potential labor problem is that high-paying managerial jobs may be filled by imported labor, causing local resentment and possible economic conflict. If the types of jobs required by the aquaculture project are not attractive to the local population, labor may have to be imported to fill even low-skilled jobs. A large influx of labor is likely to create local social and economic changes, some certain to be disruptive.

Although fish provides calories, it is usually expensive compared to other caloric sources, so its major importance is likely to be as a source of high-quality protein. We must ask first whether the local population needs additional sources of protein. If so, is aquaculture the best way to provide this? And, is the need for protein distributed throughout the population, or is it specific to groups, such as children or nursing mothers? Another issue is whether the type of fish or shellfish protein provided by aquaculture is acceptable to local palates. Taboos in many parts of the world militate against acceptance of any kind of fish as food; other taboos simply prohibit certain species or species groups (see *Oceanus*, Vol. 22, No. 1, p. 67). In the Nilote and Bantu tribes of East and South Africa, for example, fishing or eating fish can lower one's social status, since fish are considered to be unclean food. All such questions call for care in planning an aquaculture project.

Aquaculture projects may be designed to provide profits to either a private owner or the community at large. Local people may receive little or no benefit from a profitable project unless taxes collected from the enterprise are used within the community for such projects as improved schools. But even if accomplished, this circuitous return may not be perceived by the local residents as a consequence of aquaculture. If the project were owned by the municipality, there could be improved services for all local residents in the same way that an enterprise owned by a cooperative or association benefits members of the cooperative.

When private enterprise is fostered in regions where the distribution of capital is unequal, a project can result in increased social stratification. In many cases, projects are restricted to residents who can afford an initial investment, so the only individuals who can effectively take advantage of the new opportunity are those who are already well off. In Nigeria, for example, most farmers who enter aquaculture are already well established. If this kind of situation is deemed undesirable by the project planners, methods of extending credit to the needy should be investigated.

An aquaculture project may produce benefits that are more widespread than the provision of food. For example, an enterprise established with careful attention to marketing may develop new roads or communication lines to distribute the product; the same roads also would serve many other purposes. A processing facility developed in association with aquaculture could provide the means for processing other fish — those from open ocean or freshwater fishing. Credit systems designed for the aquaculture project may be expanded to include other development projects

Harvesting Tilapia *from a drained pond at a Peace Corps project in Zaire. (Photo by Roger Palm, Peace Corps)*

within the region and could lead to regional economic revitalization. Electric lines installed to run pumping equipment also could serve many other purposes in the community. Other indirect benefits may be trained labor and improved markets for fresh fish and other products. Indirect effects of an aquaculture enterprise are likely to be different in each situation. Careful assessment of the local economy would indicate which sorts of indirect benefits are most likely, and how the beneficial effects could be intensified.

There are strong arguments for the culture of native species: markets for the products already exist, as do approved methods for handling and transporting the fish; local scientists are likely to be familiar with their feeding characteristics and growing conditions; and the problem of introducing a species that may become a pest in the natural environment is avoided. In Sierra Leone, the mangrove oyster (*Crassostrea tulipa*) grows wild on mangrove roots. But this species grows faster and bigger when suspended on underwater racks. The racks provide the oysters with a constant flow of nutrients that their crowded cousins in the wild must do without at low tide. Harvested, steamed, shucked, and heat-sealed in plastic bags, these cultured oysters bring a higher price than wild ones at local markets.

However, if the cultured products do not have distinct advantages over those from the wild—such as superior quality or availability over a longer season—competition with harvest from the wild may keep selling prices too low to cover a project's expenses. The choice of a species similar to native species may allow an aquaculture project to take advantage of existing markets and improve efficiency, too. For example, cultivated varieties of native species may have faster growth or may be disease resistant. A cultivated species that is similar to native species may be particularly desirable for government projects intended as demonstrations of the potential of aquaculture. If a project is being run on a strictly profit-making basis, a species intended for a high-priced, specialized market would be the best choice, and this may or may not

Aquaculture is already a tradition in many Asian societies. At this Japanese oyster farm (right), the mollusks are grown in wire cages suspended from rafts. (Photos courtesy of Consulate General of Japan, New York)

Table 1. Aquaculture species cultivated in Latin America

Water Type	Species	Country
Freshwater (cold)	Trout (*Salmo* sp., *Salvelinus fontinalis*)	Mexico, Venezuela, Colombia, Brazil, Peru, Argentina
Freshwater (warm)	Boco chico, Coporo, Curimata (*Prochilodus* sp.)	Colombia, Brazil
Hatchery programs	Mackerel (*Basilichthys bonairensis*)	Brazil, Chile, Argentina
	Tilapia (*Tilapia* sp.)	Mexico, Brazil, Costa Rica
	Ornamental fish	Brazil, Venezuela
Cultivation in lakes	Bagre de canal (*Ictalurus punctatus*)	Mexico
	Tilapia (*Tilapia* sp.)	Mexico, Brazil, Paraguay
	Freshwater shrimp (*Macrobrachium rosenbergii*)	Honduras
Brackish or salt water	Mugilidos (*Mugil* sp.)	Colombia, Brazil
	Shrimp (*Penaeus* sp.)	Mexico, Costa Rica, Panama, Brazil, Ecuador
	Mussels (*Mytillus* sp., *Perna perna, Aulacoyma ater*)	Chile, Venezuela
	Oyster (*Crassostrea* sp.)	Venezuela

Source: Manuel Martinez, 1982. The role of non-technical factors in the development of Latin American aquaculture. In *Aquaculture Development in Less Developed Countries: Social, Economic, and Political Problems,* eds. L. J. Smith and S. Peterson, p. 57. Boulder, Colo: Westview Press.

be an introduced species. (The disadvantages of introducing exotic species was discussed in an article drawn from experiences with the introduction of the Japanese oyster [*Crassostrea gigas*] around the world — see *Oceanus*, Vol. 22, No. 1, p. 29).

Institutional Support

In Asia, a long aquacultural tradition mitigates the social and economic dilemmas that typically arise when aquaculture is introduced to a community.

There is now great interest in developing aquaculture in many parts of Latin America (Table 1) and Africa. For example, successful introductory projects have been conducted in Sierra Leone (raising mangrove oysters) and in Costa Rica (Tilapia).

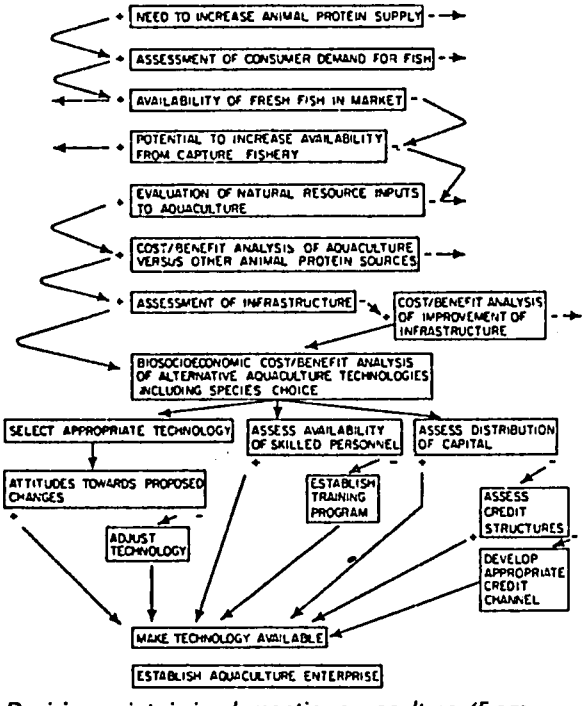
In developing countries, some rural communities, such as in Mexico, have lost their traditional subsistence systems and have become dependent on wage labor without acquiring the organizational structures that bring workers together in other societies. In these "atomistic"

societies, the mutual dependence of household members and the distrust of all others (even most other relatives in the community) create a situation in which the appropriate scale for aquaculture projects would be the household. Culturing fish could become a productive subsistence activity for these societies during the frequent lean times of unemployment. In contrast, Brazilian communities have had successful experience with sharecropping contracts in agriculture and fishing, integration of agricultural production and industrial processing, community cooperatives, and government-organized agricultural systems. These suggest a potential for aquaculture enterprises organized by the national government or operated as cooperative community activities.

Aquaculture development projects are sponsored by a range of donor agencies: private enterprises, private charitable foundations, government aid organizations, intergovernmental aid organizations (especially the United Nations' Food and Agriculture Organization), national governments, and state governments. Each of these organizations is likely to have different goals for its projects and different approaches to the introduction of a project to a community.

Awareness of community needs and community political structure varies greatly from project to project. Private enterprises, usually intent upon making a profit, may be the most careful planners of development projects because the cost of failure is felt immediately by the individuals who have organized the undertaking. In contrast, financial viability is not the sole mark of success for a government agency; the effort of development may result in lasting benefits for the community even if the aquaculture project itself is short-lived.

Successful aquaculture development depends not only on good luck and good weather, but also on the careful consideration of technological, scientific, economic, and cultural factors. Such consideration was inadequate in many past aquaculture projects, but background research well in advance of any future projects may help developers avoid some of the pitfalls that have beset the earlier ventures. Project planners should at least assess the availability of labor, the acceptability of the product, and the suitability of the project's physical site and financial structure. Under appropriate circumstances, carefully planned aquaculture projects can make a substantial contribution to the well-being of people in the developing world.



Decision points in implementing aquaculture. (From Elements in Evaluating Success and Failure in Aquaculture Projects by R. B. Pollnac, S. Peterson, and L. J. Smith in Aquaculture Development in Less Developed Countries, *eds. L. J. Smith and S. Peterson. © 1982. Westview Press, Boulder, Colo.)*

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Acknowledgments

This article was adapted from *Aquaculture Development in Less Developed Countries: Social, Economic, and Political Problems,* which was edited by the authors and published this year by Westview Press, of Boulder, Colorado. Copyright © 1982.

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