Development of Aquaculture in the Philippines

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Pond-raised milkfish for sale in local market.

DEVELOPMENT OF AQUACULTURE IN THE PHILIPPINES
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edited by Susan Peterson and H.R. Schmittou

INTRODUCTION

MOST COUNTRIES have participated in international development, either as donors or recipients, through bilateral and/or multilateral projects. In the United States, international development assistance has been supported for almost four decades, yet it is not well understood. Long-term impacts on country development are seldom measured by the typical end-of-project evaluations, and information that would contribute to the understanding of the development process is rarely available. One way to understand development better is to ensure that adequate information to measure project impact is generated throughout the process. Frequently, impact assessments are not performed because decision makers realize the lack of sufficient, reliable information. If the information is not adequate to measure impact after a project is completed, it is likely that information was not sufficient to do realistic planning and begin implementation. A second problem is that teams of specialists sent to conduct pre- and post-project studies may be poorly prepared for their tasks. Although team members may be well-trained in individual disciplines, the team is often: (1) not balanced or represented by all relevant disciplines, (2) not trained in international development, and (3) not prepared with guidelines and procedures on what information is needed and how to obtain it.

Information for planning and evaluation should be completed relative to the social, economical, institutional, governmental, environmental and technological factors involved. This report is not an example of the ideal impact assessment. It is a compromise between what was desired and what was possible, given constraints on such essentials as data collection and recording. What was attempted was to describe the system and its evolution, and then to see if existing data could be used to indicate any cause/effect relationships between development assistance and economic/social well-being in the country.

The objectives of the study were to:

1. determine the impact of aquacultural development, in general, and the contribution of cooperative (private, public and donor sectors) projects, specifically, on consumers, producers, Government of Republic of Philippines (GRP) service institutions, the environment, and overall socio-economic development of the country;
2. measure donor-assisted aquacultural project contribution to country development goals;
3. determine the return in social, economic, and other benefits to project costs;
4. identify existing and potential constraints and opportunities for future, long-range aquacultural development, and recommend ways constraints may be minimized and opportunities maximized.

This report describes the past, present, and expected future trends in Philippine aquaculture development and assesses the roles that private, public, and donor sectors have played or might play in this process.

The Philippines was chosen because of its freshwater, brackishwater, and marine aquacultures using ponds, cages, pens, and racks. The history of Philippine aquaculture spans a period of some 500 years, and fish produced through aquaculture are significant in the Filipino diet. Fish from aquaculture were from 8 percent to 12 percent of all fish produced from 1951 to present (*9*), with milkfish constituting 90 percent of all aquaculture production. The benefits of milkfish farming throughout the country include fry gathering and distribution, nursery and rearing pond production and marketing. These activities generated slightly less than 0.5 percent of the GNP (*16*). The Philippines has increased aquaculture production over the past decade, has great potential for continued growth, and has had a long and varied experience with donor-assisted aquaculture projects. In addition, the Philippines was considered a good developing world example of the partnership among producers, government institutions, and donor agencies. The information base from which an impact assessment could be compiled without generating new information was considered to be as good for the Philippines as for any other developing country. The Philippines has had a relatively stable social-political system since World War II. Many people who played roles in aquacultural development are still active. Their experiences, for the most part unrecorded until this study, provide valuable insight into the process of aquacultural development in the Philippines.

AQUACULTURAL TECHNOLOGY

Aquaculture is defined as a form of agriculture, the controlled raising of selected animals or plants in aquatic environments. Aquaculture is intended to produce harvests in greater quantity than would be naturally produced. It permits control over the production and harvest and takes advantage of areas marginally productive for other crops. The amount of control an aquaculturist exerts on production is relative. For the most part the aquaculturist manipulates only certain components of the environment to enhance natural production. A knowledge of the amount of control exercised over the culture environment is useful in assessing the status and potential for development of aquaculture in a country.

Production technologies are determined by the interaction of five factors: the physical environment, culture facilities, available nutrient inputs, species feasible for culture, and the ability of producers to balance all the factors in a profitable package. The geophysical environment is an independent variable; it is essentially fixed, though subject to minor modifications. It includes such climatic conditions as temperature cycles, rainfall patterns, and typhoons; land elevation and topography; soil characteristics (particularly water holding capacity and acidity); water availability, manageability, and quality; and geographical barriers to supplies and/or markets. If these conditions are not suitable for aquacultural development, little can be done to change them. In the Philippines, many sites in a variety of different environments are well-suited for aquacultural development. These sites include freshwater upland ponds, rice paddies, eutrophic lakes, coastal brackishwater mangrove swamps and estuaries, and shallow seas.

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[1]This report is dedicated to the memory of Tirso Jamandre, Jr., who exemplified the spirit and dedication prevalent among the past and present private and public sector pioneers of Philippine fish farming.

An analysis of the amount of control over the environment allows aquaculture to be grouped into technological levels based on three criteria: (1) the degree of physical modification of the natural environment, (2) the amount of managerial control over the natural environment, and (3) the quality and quantity of nutrient inputs added to enhance, supplement, or replace the natural food base. We group aquaculture systems into seven general technological levels.

Level 1. Extensive—only slight modification of the environment; little or incomplete control over such factors as water flow and number and weight of species raised and harvested; no nutrient inputs to enhance natural foods.

Level 2. Extensive fertilization—slight to moderate modification of the environment; moderate but generally incomplete control over water and species raised and harvested; low quality and/or quantity of fertilizer added to stimulate production of natural foods.

Level 3. Intensive fertilization—original environment modified into a distinctly new environment; generally complete control over water and species raised and harvested; quality and quantity of fertilizer used to achieve near maximum yields.

Level 4. Extensive feeding—modification and control as in 3; nutrient inputs low quality or quantity feed, usually feedstuff or agricultural by-product to supplement natural foods with or without fertilizer.

Level 5. Intensive feeding—environmental modification and control greater than 4; high quality feed, not necessarily nutritionally complete, used to supplement natural foods at near maximum quantities without aeration.

Level 6. Hyperintensive feeding—environmental modification similar to 5; control similar to 5 except much greater control over water quality, especially in terms of water flow and aeration; feed nutritionally complete and used in quantities to essentially replace natural foods; requires aeration and periodic water replacement.

Level 7. Ultra-hyperintensive feeding—totally modified, manufactured environment such as tanks and aquaria; control is relatively complete over temperature, pollution, dissolved oxygen (DO) and C02 levels, and other physical, chemical and biological activities; feed similar to 6 but in much higher quantity per unit of space.

Aquacultural Technology in the Philippines

Aquacultural practices in the Philippines are not as diverse as might be expected from a country with such a long history and diverse environments, that also is one of the world's leading producers. Milkfish culture in brackishwater ponds accounts for approximately 90 percent of total production. The remaining 10 percent comes from milkfish in lake pens, tilapia in mono- and polyculture systems in brackishwater and freshwater ponds, oysters and mussels on stakes in shallow coastal waters, and *Eucheuma* seaweed on submerged netting and racks. Other species inadvertently raised and harvested from culture facilities, especially brackishwater ponds, include a variety of finfishes, shrimps, and crabs. Technologies exist for raising these species at greater intensities, and for culturing other species presently not cultured or cultured in insignificant quantities.

Milkfish Culture in Brackishwater Ponds

Table 1 illustrates how milkfish aquaculture might be practiced at any of six levels as an example of how the concept is applied and what options might be available in the Philippines.

TABLE 1. EXPLANATION OF DIFFERENT LEVELS OF AQUACULTURE TECHNOLOGY USING MILKFISH CULTURE IN BRACKISHWATER PONDS IN THE PHILIPPINES AS THE EXAMPLE

Level/ description	Environment		Nutrient inputs
	Modification	Management control	
1. Extensive	Dikes low, narrow, weak, crooked; seaward side only. Gates: none. Mangrove incompletely cleared; bottom irregular. Canals and nursery ponds—none. Original habitat not changed.	Water flow through break in dike; level variable; drainage difficult with potholes; quality not controlled; flooding over likely. Stocked by entrapment—number, species not controlled. Harvest difficult, incomplete.	Food base exclusively naturally occurring including human caused nutrients entering water. Fertilizers and feeds—none.
2. Extensive fertilization	Dikes moderate height, width; irregular to straight; on more than seaward side. Gates wooden. Mangrove incompletely cleared. Bottom not level; stumps not removed. Canals and nursery ponds—none or poorly developed. Original habitat recognizable, but with distinct look of a fishpond.	Water flow control by gate; level variable; drainage difficult with potholes; quality not controlled; flooding over likely. Stock by entrapment and/or by species and number with little or no control over wild species. Harvest difficult.	Food base primarily naturally occurring lalab or lumut but stimulated by addition of low quality and/or quantity fertilizers.
3. Intensive fertilization	Dikes high, wide, strong; completely enclosing pond area. Gates wooden and/or concrete. Mangrove completely cleared; bottom leveled. Canals/nursery ponds well developed. Original habitat completely changed to ponds.	Water flow and level controlled by gate; depth relatively uniform; no potholes; drains completely; quality not controlled; flooding over prevented. Stock by species and number with control of wild species; stock manipulation often practiced, especially in linking pond system. Harvest complete and not difficult.	Food base generally lalab and sometimes plankton, by design. Fertilizer high quality and quantity to achieve near maximum yields. Both inorganic and organic. Feeds—none or insignificant.
4. Extensive feeding	Similar to level 3 but with better quality design and construction.	Similar to level 3 but with better water flow; depth and quality control; perhaps using pump. Stock manipulation likely using linking pond system. Harvest at will if using pump.	Similar to level 3 but using low quality and/or quantity feed.
5. Intensive feeding*	Similar to level 4.	Similar to level 4 but likely with pumps.	Similar to level 4 but with higher quality and quantity of feed.
6. Hyperintensive*	Similar to level 4.	Similar to level 5 but pumps for water transfer and standby aeration perhaps essential.	Similar to level 5 with higher quantity feed.

*Levels 5 and 6 are not presently practiced in the Philippines.

Milkfish pond aquaculture was probably introduced into the Philippines on Mactan Island in the Visayas during the 15th century from Indonesia or China. From its introduction until well into the 20th century, perhaps about 1930, it was practiced only at a level 1 technology, table 1. Yields varied between 50 and 250 kilograms per hectare with an average of not more than 100 kilograms per hectare. Level 2 technology became significant around 1930, level 3 about 1946, and some level 4 by 1960. However, levels 1 and 2 are the predominant technology levels applied to date, especially on the eastern side of the country from Luzon to Mindanao.

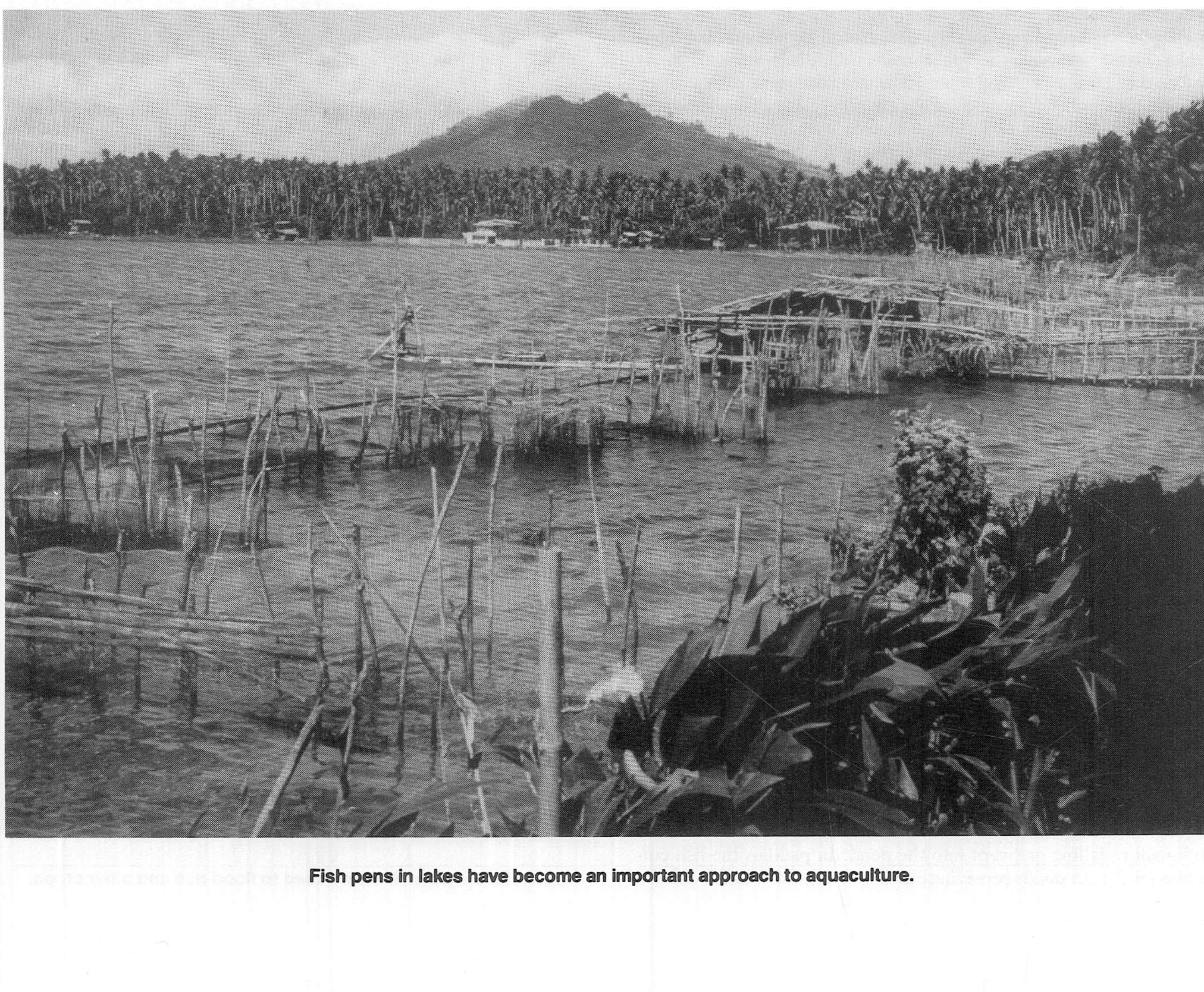
Progressive fishpond aquaculturists, especially those in western Luzon provinces and Iloilo province, practice advanced level 3 with some level 4 technology, levels which appear to be the most appropriate at this time. Pond environments of more progressive farmers are modified and subject to level 5 and some level 6 technologies; however, feeds and feeding methodologies are lacking, especially at level 6. Whether feeds will be developed to advance milkfish pond culture to levels 5, 6, or 7 will be influenced by economics rather than lack of technology. Fish feeds need to be higher in protein than those for poultry and livestock. Local by-products and feedstuffs high in protein are scarce, forcing feed producers to import fish and soybean meals and similar protein-rich materials to meet present poultry and hog diet requirements.

The trend toward feeding is accompanied by a trend toward more specialized pond design, such as those used with the linking-pond or modular systems. Farmers are beginning to use pumps to minimize or eliminate dependence on tidal fluctuations. Not only are producers using more fertilizer, they are using a higher percentage of inorganic forms.

Although some producers have shifted from milkfish to penaeid shrimp culture, the trend toward greater intensification in some areas appears to be countered by decreased intensification in others. The latter are mostly in remote areas where poor communication, transportation, and access to markets are accompanied by security problems. Intensification is often hampered by inadequate capital credit, shortages of inputs such as fertilizers and fry, decline or shift in consumer demand, and various economic and non-technological factors.

Milkfish and Tilapia Culture in Pens

Milkfish and tilapia are cultured in single species systems or, to some extent, in multiple species polyculture systems at technology levels 1, 3, and 4 in Laguna de Bay in net-fence enclosures or pens. The enclosures do not appreciably modify the original environment (level 1) of this large lake. The culturists are not able to exert much control over the environment (level 1); they control water current only by mesh size, and water depth only by placement; they have little control over water quality; they stock selected species by number and size but can only restrict "wild" stock by mesh size; drainage is not possible, so harvest by net is somewhat difficult and possibly incomplete. Fertilizers are not applied, but the natural and domestic wastes washed into the lake are equivalent to intensive fertilization (level 3). Rice bran is frequently used as a feed to "fatten" the fish



Fish pens in lakes have become an important approach to aquaculture.

before harvest (level 4). The technology applied is equivalent to only slightly more than level 1, but because of the heavy nutrient loading, the net benefits returned are equivalent to level 3 technology. Benefits would, of course, be lower in environments with fewer nutrients.

Tilapia Culture in Cages

Nile tilapia are cultured in cages in Laguna de Bay and other natural lakes. This practice, begun in the late 1970's in Laguna de Bay, is rapidly expanding to other lakes and regions. The cages are floating bamboo pens with bottoms and sides of monofilament net. The technology applied and benefits returned from cages are practically the same as for pen culture. As with pens, yields are directly proportional to the nutrients, including rice bran or other added supplements, in the water in which the cages are suspended. Efforts to expand pen or cage cultures to less fertile lakes have resulted in reduced fish production.

Tilapia Culture in Freshwater Ponds

Tilapia culture is beginning in relatively small, inland freshwater ponds for subsistence and small-scale commercial purposes. Technologies applied consist primarily of combined levels 2 and 4 with organic wastes serving as both low quality fertilizer and feed. Tilapia are also raised for subsistence at levels 1 and 2 in irrigated rice paddies modified by one or more ditches serving as fish runways or retreats. Raising fish in paddies is seriously constrained by the use of rice insecticides.

Tilapia are becoming more popular with producers and consumers; what was once the "poor man's milkfish" because of their low market value compared to milkfish, are now equal to or greater in value than milkfish in much of the country. Tilapia have excellent potential for culture in all but marine environments, and the greatest potential of any species for expansion. Culture in freshwater ponds could provide the greatest incremental increase in aquacultural production per unit area over the next several years.

Other Aquacultures

The culture of penaeid shrimp, long of interest to producers, has been an incidental or secondary culture with milkfish. Shrimp are now being produced alone and in combination with milkfish in brackishwater ponds, primarily at technology levels 3 and 4, and production is increasing with advancing technology. The major constraints to shrimp culture development are inadequate feeds and poor survival of post-larvae.

Oysters, green mussels, and *Eucheuma* seaweed are cultured in a few limited areas at level 1 technologies. Marketing appears to be the major constraint to the development of these species.

Integrated Agriculture/Aquaculture

Raising fish in integrated agriculture-aquaculture systems appears to have tremendous potential in the Philippines, especially for small-scale, home-use and limited commercial farm operations. Examples of integrated culture systems now practiced in the Philippines include fish (tilapia and others) grown with rice in paddies and chickens and/or pigs raised in cages or pens above or adjacent to a fishpond. In integrated systems the fish may be the primary economic crop, but are generally the secondary beneficiary of nutrient inputs. For example, in rice-fish cultures the purpose of fertilization is to increase rice yields and has no or limited effect on fish yield. In pig-fish cultures, the pigs are fed while fish benefit from feed wastes and manure falling or swept into the pond. In paddies the fish culture is level 1. In ponds receiving chicken or pig wastes, fish culture may be either level 2, 3, or 4, depending on the species raised and the quantity of wastes received. No information is available about the extent of integrated animal-fish production at this time.

ENVIRONMENT

The physical environment of the Philippines is highly suited for aquaculture, although the exact area now in use is disputable. The Bureau of Fisheries and Aquatic Resources (BFAR) reported a constant area of 176,030 hectares from 1973 to 1975, with a slight increase to 176,230 hectares from 1976 to 1980 (*9*). Librero (*25*) found that for the entire country the average non-operational area in a fish farm was 2.66 hectares, or 17 percent of total farm area; this would leave 146,000 hectares of pond area if the 176,000 hectares total were correct. Samson et al. (*39*) claim that aquaculture production uses 120,000 hectares of fresh and brackishwaters. Smith (*41*) concluded that there could be as much as 142,097 hectares of fishponds. Chong et al. (*13*) agree that 176,000 hectares may be an overestimate and suggest it results from inclusion of government lands for which applications for fishpond development have been made. They also say that ". . . because of the fear of land reform similar to rice land reform the owners are not revealing the real size of their farms." That is, they fear government policies that would limit the size of an individual's land holding. Most of the government lands available for conversion to fishponds—some 140,000 hectares—are coastal mangrove forest. Further conversion of mangrove, however, is limited by government policies which define other long-term uses of mangrove

Fish can be grown in water used to flood rice and other crops.

areas, such as forestry, agriculture, human settlement, industry, and ecological balance. Regardless of the exact area, the amount of fresh and brackishwater pond area in the Philippines ranks it as one of the four top countries in total fishpond area.

Development of ponds has also had some negative effects on the country. These resulted from modification of the natural habitat when ponds were created, introduction of exotic species, and the quality and quantity of nutrient and pesticide inputs used to enhance, supplement, or replace natural foods or control pests.

Mangrove Development into Fishponds

Philippine mangrove forests occur along swampy tidal zones of sea coasts and streams where water is brackish and the flora is composed primarily of *Rhizophora* mangrove and associated species. Estimates of mangrove forests in the Philippines range from 220,243 hectares (*7*) to 249,138 hectares (*30*). The existing brackishwater fishponds were developed almost exclusively from mangrove areas, and any further expansion of brackishwater fishpond area would be at the expense of mangrove forests.

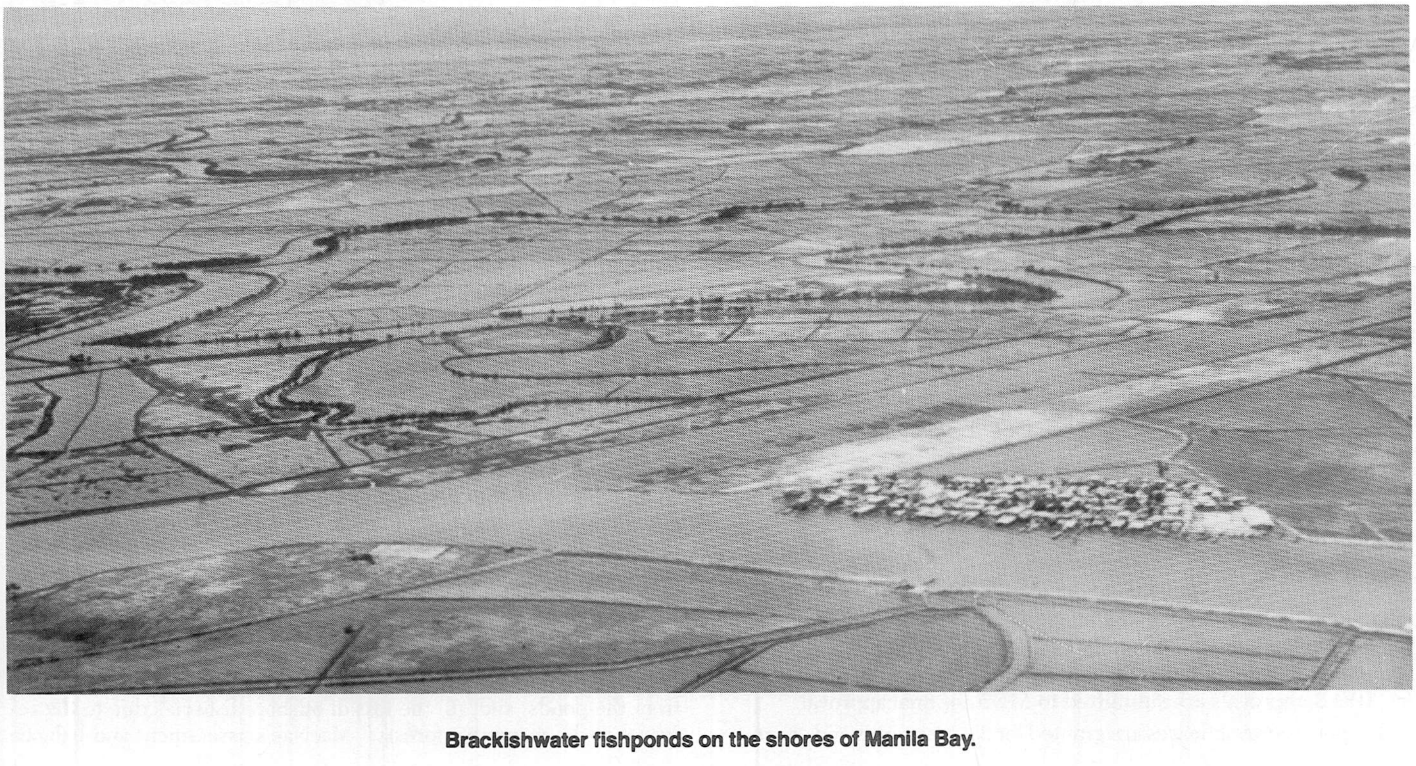
Recognition of the importance of mangrove forests was emphasized at international symposia on the biology and management of mangroves (East-West Center, Honolulu, October 8-11, 1974, and Papua, New Guinea, July 20-August 2, 1980) and at the international workshop on mangrove and estuarine area development (Manila, November 14-19, 1977). The benefits of mangrove forests to nature and society include: providing means for soil deposition; preventing flood, wave, and wind erosion; providing sanctuary, shelter, and food for birds, mammals, and other wildlife; providing spawning, nursery, and forage areas for numerous species of molluscs, crustaceans, and fishes; providing firewood, tanbark, and dyebark; providing various products of associated nipa palm including thatching materials, vinegar, and alcohol; and providing various sources of animal and vegetable foods for humans.

Mangrove forests support a characteristic fauna which includes many species that are valuable as human food. For example, certain species of shrimp are dependent on mangrove for food and shelter during their juvenile stages. Gomez (*20*) cited numerous research findings showing a positive correlation between shrimp landings and the extent of mangrove and intertidal vegetation. Turner (*45*) analyzed shrimp landings for several years for 27 locations around the world and found the data support the hypothesis that the abundance and type of commercially valuable quantities of penaeid shrimp are directly related to the absolute area and the type of estuarine-intertidal vegetation. MacNae (*31*) concluded that for some species and locations, "no mangrove; no prawns." Not as dramatic but perhaps as important to local inhabitants and coastal fishermen is the fishery within and adjacent to the mangrove areas. These areas serve as major, and sometimes exclusive, spawning, nursery, and rearing habitats for edible species of molluscs, crustaceans, and fishes.

Brown and Fischer (*8*) long ago recognized that, ". . . the mangrove swamps constitute a very valuable asset to the Philippine Islands and, if properly managed, will prove to be a permanent source of income both to the people and to the Government." Chowdhury (*14*) emphasized the importance of the mangrove zone for direct use by poor rural people: ". . . the bulk of the population that uses the mangrove environment and for whom the mangroves are to be managed are the rural poor in all countries (having mangrove environments). Any changes will affect them first."

In their natural state, mangroves are primarily used by rural poor for life essentials. This subsistence level use has been done without damage to the mangrove ecosystem because the populations relying upon the resources have remained low. However, as population increases, subsistence level users can harvest past the level of sustainable yield. But the mangrove ecosystem can be managed as a renewable, common-property resource producing fuel, food, shelter, and various products for a large number of local inhabitants and coastal or, as they are called in the Philippines, municipal fishermen. Alternatively, it can be exploited as a greatly altered private-property resource for aquaculture, agriculture, or other purposes. Between these extremes lie a host of alternatives.

This range of possible but often incompatible alternatives presents planners and decision-makers with a quandary. Their task of choosing among conflicting options is complicated by a lack of understanding of socio-economic and environmental issues involved. It is further complicated by traditional emphasis on economic evalua-



Brackishwater fishponds on the shores of Manila Bay.

tions of alternative uses of an ecosystem, especially when biological and sociological values have been quantified incompletely.

Fishpond development in mangrove forest areas generally converts a common-property, multiple-use resource into a private-property, single-purpose resource. The basis for justification of the conversion is at best weak, especially if fishponds are improperly managed. It is conceivable that a hectare of mangrove area in its natural state would contribute as much as 100 kilograms of fish catch to coastal fishermen. An even greater yield could be expected if the area were converted to pond production of shrimp—a yield whose value is twice as great as that of milkfish produced in a hectare of pond. However, no measures have been made in the Philippines on (1) the effect of pond development on the natural fishery in and adjacent to the mangrove area, or (2) on the shrimp fishery in and outside those areas. Turner (*45*) calculated the loss of shrimp and fish in trawling operations in Indonesia from converting mangrove areas to fishponds to be 767 kilograms per year for each hectare converted. These losses should be similar in the Philippines. This does not include loss from other uses of the same area of mangrove.

Clearly there are trade-offs between developing or not developing fishponds from mangroves. However, the GRP decision-makers have decided to slow and perhaps to stop further fishpond expansion into mangrove zones. Table 2 illustrates the growth of fishpond development from mangroves since 1952. During the 28-year period from 1952 to 1980, fishpond area doubled—an increase of 4.6 percent per year in the first 10 years, but only 0.8 percent per year during the last 8 years. In 1978 the Ministry of Natural Resources (MNR) reported 2,795 applications for fishponds covering 52,393 hectares or 21 to 24 percent of the remaining mangrove area in the country, table 3. However, BFAR reports only 2,130 hectares have been developed into fishponds since 1972.

The National Mangrove Committee of MNR is responsible for preparing "a comprehensive and integrated program that would incrementally rationalize and environmentalize the planning procedures for mangrove ecosystem development and management in the Philippines." The Land Classification Composite Team of the Bureau of Forest Development (BFD) classifies mangrove areas according to two basic land uses: permanent forests or alienable and disposable areas leaseable for fishponds.

Alteration of mangroves into fishponds takes several months to several years. Prolonged construction time for new ponds probably accounts for some of the discrepancy in the records on existing fishpond areas. The process begins with logging of large trees followed by cutting of smaller trees and stumps for firewood and charcoal. If not completely cleared, the area will regenerate into mangrove. However, if completely cleared and not used for fishponds, the area often becomes a desert because the soil rapidly deteriorates.

Estimates on remaining mangrove areas vary depending on the source of data. Comparisons are made in table 3 of developed fishpond areas (BFAR source) with areas that remain in mangrove (NRMC and BFD) and areas designated as available for fishpond development (BFD). One-third of the remaining mangroves, or 74,130 hectares (NRMC), are open canopy area. Bina et al. (*7*), cited by Gomez (*20*), consider open canopy to represent "the preliminary stage of fishpond/saltbed conversion." However, BFD classifies only 22,904 hectares, or less than 10 percent of the BFD estimated total, to be available to fishpond development.

A summary of the major regulations concerning fishpond development and practices in mangrove areas follows:

1. PD 704 BFD permits clear cutting of mangroves in areas zoned or already disposed for fishpond development.

2. Areas declared available for fishpond development by BFD are released to the BFAR for administrative control; applications for development of these areas must be accompanied by feasibility studies; BFAR approvals are submitted to MNR for final approval.

3. Upon approval, leases are granted for 25-year terms and are renewable for an additional 25 years; leasees are required to submit under oath semi-annual reports of development, operations, and production.

4. Leasees are given 5 years to fully develop their holdings to commercial scale or forfeit the lease agreement.

5. PD 705 regulations on development of mangroves into fishponds exclude from development 40-meter strips along rivers, lakes, and other inland waters, and 100-meter strips facing bays and the sea.

6. PD 905 holders of leases are required to plant trees extending at least 20 meters from the edge of tidal streams; people are prohibited from cutting, injuring, or otherwise damaging planted and natural trees in these areas without authority.

7. Proclamations have designated mangroves as "Wilderness Areas" (P-2151) and "Mangrove Swamp Forest Reserves" (P-2152), which strictly exclude fishpond development.

TABLE 2. INCREASE IN BRACKISHWATER FISHPOND AREA SINCE 1952

Year	Developed area, ha	Increased area, ha	Percent increase	
			Period	Year
1952	88,681	—	—	—
1962	129,062	40,381	46	4.6
1972	174,101	45,039	35	3.5
1982	176,231	2,130	1	.8
Total		87,550	99	3.5

TABLE 3. EXISTING MANGROVE AREA IN THE PHILIPPINES[1]

Mangrove status	Hectares	Mangrove area, pct.	Total area, pct.	Source
Closed canopy	146,140	66.4	36.9	
Open canopy[2]	74,103	33.6	18.7	
Subtotal	220,243	100.0	55.5	NRMC
Fishponds	176,231	—	44.5	BFAR
Total	396,474	—	100.0	
Permanent forest	226,234	90.8	53.2	
Disposable	22,904	9.2	5.4	
Subtotal	249,138	100.0	58.6	BFD
Fishponds	176,231	—	41.4	BFAR
Total	425,369	—	100.0	

[1]Estimates by Natural Resources Management Center (NRMC), Bureau of Forest Development (BFD), and Bureau of Fisheries and Aquatic Resources (BFAR).

[2]Open canopy represents "the preliminary stage of fishpond/salt bed conversion" (Bina et al. (*7*) by Gomez (*20*)).

The GRP has taken steps to protect the mangrove zones from destruction—steps that are often unpopular with fishpond developers. However, developers and all users of mangrove areas need to be educated regarding the rational allocation and protection of mangrove resources. The management program depends on definite goals and clearly stated policies formulated within the social, ecological, political, institutional, and economic framework. Lindblom, cited by Baines (*4*), declared that goals in mangrove resource use have tended to evolve from "a complex history of vaguely expressed public opinion, faulty interpretations, and political opportunism." The GRP might consider allowing some fishponds to revert to mangrove or replanting mangrove in fishpond areas with low yields.

MacNae (*31*) concluded that, "Before modifying a mangrove area in any way, for salt production or for fish- or prawn-pond construction, it is necessary to assess and balance: (1) the quantity and market value of timber products; (2) the value of the fishery of prawns, crabs, molluscs, and fish both within and just offshore from a mangrove area, and to balance those with (3) the cost of extirpation of mangrove trees (root, trunk and branch); (4) the cost of building culture ponds taking into account the fertility of the soil and the usefulness of the soil in making "bunds" (dikes); (5) the potential return from the ponds, and, (6) the loss of offshore fisheries due to the removal of the mangrove forests." MacNae's assessment and balance considerations should include social and environmental factors as well as economics.

Freshwater Aquaculture

The Philippines also has a potential for freshwater fish production. A recent estimate is 500,000 hectares of freshwater areas available for fisheries development (2). Some of this potential is beginning to be realized in Laguna de Bay where milkfish are being raised in pens. This culture system has emerged as a major industry only in the last decade; thus, the statistics reflecting its importance are just becoming available.

The construction of ponds for freshwater aquaculture is done almost exclusively in areas already modified for some type of agriculture. The environmental impact on such areas is generally positive. Water held in ponds is available to humans and wildlife. Ponding may raise the water level in nearby wells during dry seasons when water could be limited or unavailable from other sources.

Pens and Cages in Lakes

The impact of fishpens and cages in lakes is unknown. The statements which follow are speculations based on principles of aquatic ecology and aquaculture as they relate to present pen and cage aquacultural practices. The physical placement of pens and cages does little to alter the environment. The technology applied is primarily of levels 1 and 2, which contribute little to eutrophication. In fact, eutrophication is probably decreased by removal of nutrients in the tons of fish harvested from the culture facilities. The fishes used in this culture are primarily milkfish and tilapia, which are efficient at feeding on plankton, the primary food source in the lakes where pens and cages are feasible. This efficiency enables these fishes to compete effectively with and perhaps displace native species. Tilapia freely reproduce inside and outside the facilities, but milkfish do not reproduce. Thus, where tilapia exist, the environment is permanently altered; where milkfish exist without tilapia, alterations may be only temporary. Pens and cages may provide shelter for some species allowing them to grow to larger sizes and to reproduce before being caught. This is thought to be happening with *Arius* catfish.

Some socio-economic impacts of pens and cages on lake fishermen have been reported in the news media. Such reports include displacement of fishermen from their traditional fishing areas, poaching from pens resulting in attacks and shootings of people by security guards, and the accusation that wealthy pen and cage owners are utilizing the public resource at the expense of the poor traditional users. Obviously, pens and cages reduce the area where fishermen can fish, which may result in lower catch and reduced income.

Introduction of Exotic Species

Except for the negative environmental impact of mangrove destruction, the greatest destruction to Philippine aquatic environments could be from introduced species. At least 15 different species of fishes, crustaceans, and molluscs have been introduced into the Philippines for aquacultural purposes during this century, but no accurate information exists on the actual number of species introduced nor on their distribution within the country. Most known introduced species are well established. The positive or negative effects from the introduced species are not known. Regulations to prevent indiscriminate introductions of exotic species are thought to be ineffective, and introductions of new species and reintroductions of previously introduced species are assumed to be continuing.

Pesticides in Fishponds

The usual pesticides used in brackishwater ponds are molluscicides and piscicides. All alter the environment if not contained until they have detoxified or dispersed. Persistent, residual chemicals are by far the most damaging to the environment. Endrin, a highly residual chlorinated hydrocarbon insecticide, is lethal to many aquatic animals, including most fish, at concentrations as low as 0.1 to 0.3 parts per billion, and remains toxic for several years. Endrin and some other persistent pesticides have been banned from use in fishponds, but they continue to be used illegally. In recent years both the private and public sectors have become more aware of negative effects of pesticides on the environment and the food chain.

Other Environmental Considerations

Finfish and crustacean aquacultures have not been implicated in incidences of communicable diseases for humans. Current nutrient additions are too low to be major influences on the environment. There are, however, possible negative impacts of aquaculture activities on the environment; the impact of removing wild milkfish fry or fry of other species on the natural stocks of those species is not known, nor is the effect of diking tidal streams and natural drainage avenues of flood waters to make fishponds.

SOCIAL AND ECONOMIC FACTORS IN AQUACULTURAL DEVELOPMENT

Milkfish Producers

Little documentation on the social organization of milkfish production exists with the exception of Smith's (*41*) description of milkfish fry gatherers, and interviews with fishpond operators by Librero (*25,28*), Chong et al. (*13*), and Yengoyan (47). Yengoyan described pond operators as members of one of three groups or types. The large producers, those with fishponds greater than 15 hectares, viewed fishponds as big business and they characteristically reinvested their earnings from the ponds into increasing production either from additional ponds purchased or rented, or for pond improvement—acquiring fertilizer, feeds, and/or knowledge. This group is approximately 10 percent of the producers but is responsible for up to 75 percent of the production. He described them as actively manipulating the environment. The second group of producers, about 15 percent of the fishpond owners, were described as men with more limited knowledge of the ecosystem who farmed up to 15 hectares. Instead of reinvesting in fishpond development, most of these pond operators invested 50 percent or more of their earnings in sugar producing lands. They appear to have chosen diversified agriculture, and according to Yengoyan, "the amount of profit generated through maintaining different agricultural activities acts as a cushion in which all options are exploited." However, the data given do not indicate whether they: (1) inherited their ponds and aquacultural plots, (2) started as farmers and were attracted to pond operations because of high probabilities for profit, (3) started with fish ponds and added agricultural land because the fishponds demanded more capital than they had access to for optimal development, or (4) because the ponds were production limited for other reasons. Yengoyan described them as limited by money and information, but with the basic knowledge that bigger is better. Expansion was limited by hesitation to make greater capital investment, hire laborers, acquire knowledge on the technology of increasing production, and obtain marketing information. Although he offered no explanation, he reported that the greatest impediment to market development by these mid-range pond operators was having to learn how to deal with Chinese fish buyers in Roxas and Manila. From that statement we could infer that ethnicity is an important factor in product distribution; however, we saw no other references to ethnic differences being important factors in aquaculture development or marketing. If major urban markets are run by Chinese or any other ethnic group, it would be important to know what the relationships were between suppliers and buyers, differences in loan or credit systems, and other interactions.

The third category of fishpond owners, which makes up 75 percent of the individuals, was briefly described as dependent on a mixture of aquaculture and agriculture, growing paddy rice on small plots and doing swidden cultivation for sugar in the less productive farmlands.

Fishpond operators from the Capiz area may be similar to pond owners throughout the country, although Librero (*25*) reports greater non-pond economic activity for the pond operators with more than 15 hectares than Yengoyan did. For example, her data show that 66 percent of ponds of greater than 50 hectares were operated by caretakers. From the available information, it is not clear what role owners play in decision-making regarding pond management when there is a caretaker. However, it is assumed that high-yielding, large farms receive a great deal of attention from their owners even though day-to-day operations are done by caretakers.

Labor Organization, Education, and Employment

Most fishpond owners and caretakers are men, and information about them from all sources is presented in the context of households whose joint labor is included in estimated annual incomes. For the 6 percent of female pond owners and 1 percent of female caretakers reported by Librero et al. (*26*), it is not known if they inherited or purchased their ponds, if they are entrepreneurs, or if they are part of a trend toward greater involvement of women in fishpond businesses, nor is there information about the size of farms they operate or the management inputs they use as compared to other farmers in their regions. The general assumption of reports surveyed is that women do not play an active role in fishpond operations, but rather that they maintain traditional activities. However, women hold the purse in most families and are instrumental in planning and budgeting. Women were most often included in statistics as unpaid family labor, as they are in the fishing industry. MNR et al. (*30*) estimated that for capture fishing, 25 percent of unpaid labor came from women who do most of the post-capture activities, such as cleaning, sorting, and marketing fish.

Hired personnel on a milkfish farm commonly include a caretaker, laborers, and security guards. On a few big farms, managers, secretaries, and housekeepers are also employed. An average fishpond operation employs 12 people including caretaker and laborers (*33*). Caretakers are usually paid a fixed monthly salary; in some cases a commission is added. As farm size increases, the caretaker is gradually removed from a profit sharing basis and is shifted to a fixed salary (*25*). In 1974, the monthly caretaker salary was equivalent to P7 per day, which was a little higher than minimum wage for agriculture labor for that year. Moreover, the caretakers are more or less assured of year-round employment unlike laborers who are hired as the need arises.

Sixty-five percent of pond owners had gone to college, and the more educated owned larger fishponds (*25*). This high percentage of college-educated fish farmers indicates they have access to published materials on technology and management techniques and are interested in fishpond development as a business venture. Their education may be an indication of their willingness to invest capital in research for aquaculture development. This assumption is reinforced by the relatively higher education attained by caretakers compared to ordinary farmers or fishermen. A majority of the caretakers received formal education, with one-fourth reaching high school and about 8 percent reaching college.

Among all pond owners interviewed by Librero (*25*), 62 percent were operated by the owner, although none of them considered the pond operations as full-time work. Owners reported they spent less than half their working time on fishpond business. A high level of education among pond owners implies that they have a range of business or farming opportunities. But the data show that a surprisingly high number (7 percent) of the owner-operators fished during their working time away from the pond, as did 28 percent of the caretakers. The fact that owners and caretakers reported fishing as an alternative occupation is surprising because in surveys of fishermen, none reported fishpond labor or operation as an alternative source of work (*24*).

Harvest operations for pond-raised fish.

Fishpond owners averaged 50 years of age, with caretakers slightly younger at 46 years. The small-scale fishermen in Leyte were on the average much younger than fishpond owners and caretakers (age 25-44 years) and less educated, with fewer than 40 percent of them having education beyond primary grades (*24*). Furthermore, their children were also poorly educated. However, the fishermen said that if they had money to educate their children they would want them to become fishery experts or take up an occupation related to fishing.

Employment trends over the past decade are difficult to document because the data are compiled under the general heading of agriculture, fisheries, and forestry. Rough estimates, however, indicate that the fishing industry employs approximately 900,000 workers, which is about 10 percent of all agricultural workers and about 5 percent of the total work force. Approximately 18 percent of fishery workers are wage/salary earners, 66 percent are self-employed, 2 percent are employers, and 14 percent are unpaid family workers. A majority of 67 percent are engaged in municipal fisheries, 5 percent in commercial fisheries, 22 percent in aquaculture and other inland fisheries, and 6 percent in fish processing.

A government survey concluded that, among graduates of agriculture, forestry, and fisheries programs, the largest proportion of delayed employment was in fisheries where almost two-thirds of graduates had to wait an average of 2.5 years before becoming employed. Among those who did not get immediate employment, 44 percent were unemployed for 3 years or more. Statistics on investment and employment estimates have been based on constant multipliers (e.g. P10,000 per hectare investment and one person per hectare of fishpond). Any inaccuracies, therefore, in the area estimates are accumulated in investment and employment figures. Moreover, our analysis in this paper shows differences in the level of investment as well as employment. The GRP data on employment aggregate workers in agriculture, forestry, and fisheries, and no attempt has been made to separate fisheries, more particularly aquaculture, from the marine and freshwater fishing industry.

Family

In the study of Capiz fish farmers, Yengoyan (*47*) found that average family size was smaller than for agricultural workers. He assumed family size results from family planning strategies and postulated that among fishpond owners, fewer sons are needed because labor can easily be hired. He also pointed out the disadvantages of dividing an inheritance into ponds of insufficient size. Yengoyan used smaller family size to explain discrepancies in standard of living he found among sugar and rice farmers and fishpond operators. Individual head-of-household incomes were higher among sugar and rice farmers, but because of large family size, their standard of living was lower than for fish farmers.

Chong et al. (*13*) stated that the extended Filipino family may explain why some fishponds are not operated according to profit-maximizing principles. Many ponds are owned by families and run with the expectation that the family will benefit from the harvest and sale of the products, but that not all of the benefits will be in cash. They give the example that some farms are run on a rotational basis among family members, or that family members act as caretakers.

Fishpond Operators' Associations

There are more than 30 fishfarm producer associations federated at the national level. Membership is voluntary and draws largely from the more successful and educated fishpond operators (*13*). Among the 1,175 sample respondents in the Librero (25) aquaculture survey, only 134, or 11 percent, were members of aquaculture organizations. These associations lobby the government and serve as a source of information for their members. Benefits of membership vary depending on the degree of member participation and leadership. The most common services are fry allocation and bulk purchase of inputs such as fertilizers. Buying and selling on behalf of members are practiced in only a few associations.

Value of Fishponds

Brackishwater fishponds are valuable real estate, and although some of their value results from good management, Herre and Mendoza (*21*) point out that the ponds themselves have different values depending on the distance to market, distance to the open bay, the volume of water and its depth in the adjacent river or creek, the age of the pond, the quality of the soil in relation to growth of food, cleanliness of the pond, and the liability to flooding by freshwater. From the 1950's to 1970, values rose by 4.2 percent per year, and by more than 10 percent per year in the 1970's. General estimates of current fishpond values are approximately P50,000 to 80,000 per hectare. Some well developed ponds are valued at more than P100,000 per hectare. Such ponds lease for as much as P5,000 per hectare.

Fishpond Operating Costs

Librero (27) estimates that to operate the average pond (13.5 hectares) for a year, an operator would need a minimum of P19,390 or P1,437 per hectare to pay for stocking (31 percent of costs as discussed in detail below), labor (17 percent), fertilizer (15 percent), and other costs. Labor use is seasonal, with many of the laborers hired as casual labor for specific jobs such as dike repair or harvesting. Librero et al. (*26*) estimated an average of 16.8 man-days per hectare for all operations involved with one crop. Dike, screen and gate repair require 50 percent of the labor, but this is done over a short time. Stocking uses very little labor—estimated at 1 hour per hectare.

These costs can be contrasted with operating costs for small boat fishermen. Laopao and Latorre (*24*) report that the average operating cost for non-motorized boats was P4,918 and for motorized boats, approximately P20,000. They also assumed that non-motorized boats depend on family labor; thus, this input would be unmeasured just as it is for fishpond operators. Ninety-two percent of capital outlay for the small fishing boats went to operating rather than fixed costs. The major operating expenses were for labor (41 percent) and fuel (25 percent). Reported fixed costs were for permits, repairs, and interest on loans. However, since only about 30 percent of fishermen get permits, and 80 percent to 90 percent default on government loans, these fixed costs are minor considerations when compared to operating costs.

Milkfish Fry

Fry gatherers are paid on a share system rather than a fixed wage. Chong et al. (*13*) report that earnings from daily catch are divided equally among the team members with an extra share for the owner of the gear. Since most fry gatherers had other jobs, many as fishermen, the fry gathering contributed less than 25 percent to their annual incomes. Smith (*41*) estimates that fry gatherers earn approximately P700 per year, and fry dealers, with the largest three excluded, earn P9,254. Fry concessions managed by the municipalities provide an average of 12.7 percent to annual municipal income, and employment for fry gatherers, concessionaires, dealers, and nursery pond operators also has multiplier effects in the community, table 4. In 1976, net returns to fry and fingerling businesses were poorest for fry gatherers, who on the average earned only 70 percent of minimum wage (*41*). However, net returns to capital, labor, unpaid family labor, management, and risk of marketing was 3.6 percent for concessionaires, 14.9 percent for dealers, and 27.7 percent for nursery pond operators.

Milkfish Fry Marketing

Fry concessions also demand high capital investment. Chong et al. (*13*) estimated that the most productive fry grounds can demand fees of P40,000, which encouraged concessionaires to integrate vertically. Fry marketing was described by Smith (*41*) as a well-established, partially government-controlled enterprise with some vertical integration among concessionaires, dealers, nursery pond and rearing pond operators. The primary handlers, in this case fry gatherers, earn below average incomes, and have no marketing organization and little access to price information. Furthermore, they are constrained to selling in a limited market because of government regulations and risks of loss during transport over greater distance. About 82 percent of the interregional fry trade goes to the nursery ponds in the Metro Manila area. Except for the Southern Tagalog region, fry can be transported within the region of catch without shipping permits and auxiliary invoices. Consequently, no data are available on intraregional trade flows.

From interviews of fry concessionaires in 1975, Librero estimated that 13 percent of the fry came from within the same village; 14 percent came from other villages within the same municipality; 38 percent from other municipalities within the same province; and 35 percent from outside the province. Using data from 1976 when fry were followed through the marketing channels, Smith estimated that 14 percent of the fry from Southern Mindanao, 40 percent in Northern Mindanao, 47 percent in Western Visayas, and 18 percent in Illocos were stocked in fishponds in the same regions where caught. Excluding re-exports from Bulacan and Rizal provinces to other regions, he estimated that the total number of fry in interregional trade in 1976 was 745 million distributed quarterly as follows: 79 million (10.7 percent) in the first quarter of the year; 492.1 million (66.1 percent) in the second quarter; 111.3 million (14.9 percent) in the third quarter; and 61.9 million (8.3 percent) in the fourth quarter.

Mindanao, Southern Mindanao in particular, is the major fry ex-

TABLE 4. INDICATORS OF STABILITY AND INTEGRATION OF THE FRY AND FINGERLING INDUSTRIES

Item	Gatherers	Concessionaires	Dealers	Nursery pond operators	Rearing pond operators	Fishpen operators
Year in business						
A. Average	14.7	6.9	11.5	16.9	16.1	3.9
B. Range	2.44	1.30	2.37	2.33	3.48	1.7
C. Percent with off periods	10	31	14	03	02	20
Competitors						
A. Approximate no. of close competitors	na	11	14	16	many	many
B. Percent believing industry is more competitive in 1976 than 5 years ago	54	60	93	93	90	—
Suppliers						
A. No. from which to choose	—	290	25	20	8	4
B. No. from which bought	—	290	15	6	3	1
C. Percent with wide choice	na	na	86	97	83	67
D. Change in supplier choice	—	na	less	less	—	—
E. No. of years with major supplier	—	na	3.5	5.0	5.3	2.4
Outlets						
A. No. to which one sells/season	6	6	18	14	—	—
B. No. to which one sells/month	5	2	5	3	—	—
C. Percent with wide choice	30	55	77	—	na	na
D. Change since 1975	no	no	more	less	—	—
E. No. of years with major outlet	3.2	3.5	3.5	2.6	—	—
Integration						
A. Vertical	none	31% own rearing ponds	42% own rearing ponds; 6% own nursery ponds	21% own concessions; 31% own rearing ponds; 10% own fishpens;	none	none
B. Horizontal	2% gather from more than 1 fry ground	44% have more than 1 concession; av. 2.1 fry grounds	none	23% have nursery ponds in more than one location	27% have rearing ponds in more than one location	30% have fishpens in more than one location

Source: Smith *(42)*, p. 78.

porter (62.3 percent) while Bulacan and Rizal provinces with no fry grounds are deficit areas with 18,095 hectares of fishponds. Nursery-pond operators in Bulacan and Rizal are the major financing source for concessionaires in Southern Mindanao.

The fingerling industry, operated by nursery pond operators in Rizal, Bulacan, and to a lesser extent in Pampanga, developed to supply fingerlings to fishpond operators who did not want to assume the risks of high mortalities associated with fry stocking. Nursery-pond operators claim to achieve 65 percent or greater survival rates from fry to 3-inch fingerlings, whereas an ordinary fishpond operator who stocks fry directly into rearing ponds could only achieve about 50 percent survival over the same rearing period *(41)*.

When the fishpens, which must use fingerlings rather than fry for stocking, were established in Laguna de Bay, the fingerling business received a substantial boost. Price of fingerlings increased from P160 per thousand in 1972 to P240 in 1974-76. Assuming an average stocking rate of 35,000 fingerlings per hectare per year, the fingerling requirements soared to about 245 million *(41)*in 1976 when fishpen area reached 7,000 hectares.

Processing and Marketing

Fishpond operators have more control over the timing of harvest than do fry gatherers or capture fishermen. The decision to harvest milkfish is often dictated by economic and operational considerations such as: (1) prevailing market prices; (2) phase of the tide; (3) weather conditions; (4) food supply in the pond; and (5) desired size (25). Yengoyan *(47)* stated that large-scale fish farmers may withhold fish from the market if prices are depressed because they have adequate cash resources to maintain their operations. For a large producer the amount of available cash probably affects marketing behavior less than does information about regional or national demand. A producer about to harvest several tons of milkfish is interested in price details to the last centavo; a smaller operator may be influenced by the expense of gathering more information and thus be more interested in selling.

Most milkfish production (98 percent) is intended for the fresh fish market rather than for home consumption or processing. The major market is the Manila area, where some of the fish is frozen for export and some is canned. There are three milkfish canning plants on Luzon and one in the Visayas. Deboned milkfish is becoming popular, especially in Iloilo, but this type of processing is still new.

There is a wide variation in production by region and in regional problems, such as distance from market, cost of transportation, availability of market information, varying costs of inputs, and lack of familiarity with other domestic or export markets, which affect

Milkfish being transported to markets.

net earnings. The distance from the farm to a milkfish market averages approximately 50 kilometers although Librero et al. (*26*) estimated that 10 percent of milkfish is sold in the same neighborhood and 38 percent in the same municipality. The fish may be sold through a broker (who must be licensed), to a wholesaler (with or without trucking service), to a wholesaler/retailer, or to an exporter. Typically milkfish are sold to a wholesaler at prices which vary by several pesos per kilogram. Librero et al. (*26*) described first sale prices at P2.23 to P5.88 per kilogram. Under direct retailing, which was the most profitable but the most difficult to arrange for the fishpond operator, prices ranged from P3.82 to P5.69 per kilogram. Consignment or broker selling prices ranged from P3.78 to P5.72 per kilogram before commission (*28*). Regional differences in marketing procedures vary by (1) volume of fish produced at a single harvest—a large producer profits by acting as his own broker, but a small producer does not; (2) volume of fish available—a broker may have better and broader contacts for moving fish in a sluggish market; and (3) the personalities of the brokers and wholesalers and their reputation in the community, regional, and national markets. In Quezon, 54 percent of fishpond operators sold through brokers (*29*).

The major flow of milkfish from either Luzon, Visayas, or Mindanao was to Manila. On Luzon, minor flows were from the Pangasinan area to Northern Luzon, Bicol and Palawan to Manila, and Laguna Lake to Pangasinan then back to Manila. In the Visayas, minor flows were largely to other islands in the area and to Mindanao, particularly Cagayan de Oro and Davao. Minor flows in Mindanao were largely to Cagayan de Oro.

In another study, Sevilleja and McCoy (*40*) reported that because of the proximity of Central Luzon to Metro Manila, a considerable amount of all fish produced in the Central Luzon area is moved to Metro Manila. Medina and Guerrero indicated that 71 percent of the tilapia and 67 percent of the carp sold in Manila came from Central Luzon provinces. On the other hand, fish were also transported into the region. A study by Nicolas et al. (*35*) of the Navotas fish market indicated that about 29 percent of the fish from Navotas were moved to the Northern provinces. A report by the Philippine Fish Marketing Authority also indicated that 20 percent of the port unloadings went outside of Metro Manila. Approximately 64 percent of total unloadings went to Central Luzon provinces. Substantial quantities of smoked and dried fish were also transported into the region.

Fish exports have become a major component of Philippine foreign exchange earnings, increasing from 1,000 metric tons in 1965 to 76,000 in 1980, table 5. Tuna exports accounted for almost one-third of total quantity exported in 1980 and over one-half of the total value. Milkfish constitutes a small proportion of total exports, but volume has almost tripled for the 5-year period 1975-80. If this trend continues, the price of milkfish is likely to remain high in the face of broader market choices for producers, particularly in the Manila area where fish for export would be a subset of the Manila area market redistribution, tables 5 and 6.

Port facilities, ice plants, and cold storage facilities are inadequate, and the inconvenient location of some facilities further exacerbates the problem. Ice plants in Metro Manila account for 53 percent of the country's ice plant operating capacity while being used for only 12 percent of total production. Region IV (Southern Tagalog), the largest contributor to total fish production, has only 159,432 metric tons of ice supply (*23*). Librero et al. (*29*) conclude that market facilities such as buildings or ice supply, as well as the mechanisms for selling through a variety of buyers or brokers, are not generally impediments to distribution of fresh fish from the producer to the consumer. In specific cases, limitations in marketing choices result in unacceptable earnings for a producer, especially in the period July to October (*38*).

TABLE 5. SELECTED FISH EXPORTS: 1965, 1970, 1975, 1980, IN THOUSANDS OF KILOGRAMS AND THOUSANDS OF PESOS

Product	1965	1970	1975	1980
Total exports				
Amount	1,104	3,407	25,988	76,179
Value	2,776	17,986	327,996	939,295
Shrimp/prawns				
Amount	35	574	1,672	2,717
Pct. of total exports	3.2	16.9	6.4	3.6
Value	152	7,951	51,708	154,522
Pct. of total exports	5.5	44.2	15.8	16.4
Tuna				
Amount	—	820	8,120	47,290
Pct. of total exports	—	24.1	31.2	62.1
Value	—	2,519	36,616	489,951
Pct. of total exports	—	14.0	11.2	52.2
Milkfish				
Amount	—	97	191	551
Pct. of total exports	—	2.8	.7	.7
Value	—	388	2,652	8,143
Pct. of total exports	—	2.2	.8	.9

Source: BFAR, Fisheries Statistics of the Philippines (*9*).

TABLE 6. FISH SUPPLY AND USE, 1970-1980, IN THOUSANDS OF METRIC TONS

Year	Production	Imports	Exports	Per capita use, kg
1970	988.8	103.6	2.9	28.8
1971	1,023.1	112.9	6.7	29.1
1972	1,122.4	108.9	10.7	30.5
1973	1,204.8	61.4	15.8	31.2
1974	1,268.4	93.8	18.2	32.1
1975	1,336.8	164.4	14.8	33.3
1976	1,393.5	118.0	16.1	33.2
1977	1,574.0	73.0	26.1	34.1
1978	1,567.0	93.9	48.4	34.0
1979	1,578.0	104.1	64.9	33.1
1980	1,672.2	53.4	76.2	31.5

Source: 1970-79 data from Integrated Agricultural Production and Marketing Project, Ministry of Agriculture. 1980 data calculated based on BFAR statistics.

Retail Prices of Milkfish by Region

Slight variations were observed in the retail prices for milkfish among the regions. On the average, Western Visayas had the lowest prices, followed by Central and Eastern Visayas. For the period 1970-81, highest prices were found in Cagayan Valley. As of 1981, however, Southern Tagalog registered the highest price at P16.33 per kilogram, as compared to the lowest price of P10.84 per kilogram in Central and Eastern Visayas.

Retail prices for milkfish increased at the rate of 12 to 18 percent per annum. Increased demands have apparently outweighed the growth in supply of milkfish in Southern Tagalog, as retail prices soared by 18 percent per year despite the additional production from fishpens.

Wholesale and retail prices of milkfish and other common fishes are collected daily by the Bureau of Agriculture Economics (BAEcon) in 48 major trading centers around the Philippines. However, these data are not published. While researchers and other users can copy such data, use is limited by an unawareness of its existence. These data are handwritten on loose sheets which increase the probability of loss. The Philippine Fish Marketing Authority (PFMA) also collects price information from major fish landing areas. BAEcon and PFMA should coordinate with each other in this activity to avoid the possibility of conflicting data as well as for better use of data collecting resources. Tilapia, which has become important in the fish market, has been neglected, and BAEcon should add this group to its data collection process.

Income from Fishponds, Fry, and Capture Fishing

Librero (*28*) estimated that the average annual farm income was P30,953 or P2,294 per hectare. Most employment figures for aquaculture are based on the doubtful assumption that one man is employed per hectare. If true, average annual income from fishponds would be P2,294 per man per year. However, that assumption is discredited by the income figures provided in various reports by Librero. From this, a caretaker could work 2 hectares and an owner 6 hectares at the P2,294 per hectare income rate. Compared to small-boat fishermen, as estimated by Laopao and Latorre (*24*) for Leyte, the average annual income from fishing for the boat owner was P5,100 and for crew P3,720. There are also differences among municipal fishermen. Net income of those using motorized fishing boats averaged P5,508, while those in non-motorized boats earned P3,095. Fishing income was approximately 68 percent of the total. Hence, annual income was actually higher for the fishing households. Families of fishpond laborers, caretakers, and owners also depended upon additional sources of income. Librero (*25*) estimated the average annual income for caretakers to be P10,334 and for owners, four times that amount, or over P40,000 per year.

Consumption

The most current (1980) population estimates for the Philippines are 24.0 million males and 23.9 million females with more than 30 percent of the population less than 10 years of age and 4.7 percent greater than 60 years. Population growth rate is 2.64 percent per annum. As a result of population increases throughout this century, the demand for animal protein is likely to double in 20 years. Table 7 shows the contribution of meat, poultry, eggs, dairy products, and fish, which provide more than 50 percent of the protein consumed, to the diet of Filipinos surveyed during 1977-80. The table also shows the difference between consumption by all households combined and by those families dependent on fishing as a major source of livelihood. The comparison suggests that fishing families consume the product of their labor rather than spending scarce cash on alternative protein sources.

While average protein consumption is considered adequate (103 percent of minimum recommended levels) for the country as a whole, Smith (*41*) estimated 70-80 percent of the population consumed less than 50 grams of protein per day. Nutrient intake levels were alarmingly low for households with annual per capita income less than P500 and for households of farm workers and small-scale or hired fishermen (*19*).

Milkfish are considered affordable by upper and middle class consumers but are important to all classes on festive occasions. Most milkfish producers gear production for harvest at a size of 4 or 5 fish per kilogram. Thus, a single milkfish may cost P2 to P3, a high price in light of the minimum wage of P14-P18 per day. However, smaller milkfish are available on the market for less than P1 and are more affordable by the lower income consumers. Elasticities of demand for fish were estimated at 0.22 for Metro Manila, 0.21 for other urban areas, and 0.23 for rural areas. The elasticities are by location, but the location is also indicative of income levels as inhabitants of Metro Manila have higher incomes than other urban and rural dwellers.

To summarize fish consumption information, fish protein is more

TABLE 7. ANNUAL PER CAPITA CONSUMPTION OF FISH, MEATS, DAIRY PRODUCTS, AND EGGS

Item	All households, kg	Fishing households, kg
Pork	5.9	4.2
Beef	2.1	1.6
Poultry	3.6	2.6
Eggs	2.6	2.1
Dairy products	6.3	5.4
Fish	23.2	24.4
Total	43.7	40.3

From Aviguetero et al. (*3*), using data from 1977-80.

A rural housewife preparing milkfish.

than half of all animal protein consumed, and the demand for fish increases with population growth. Imported fish contribute 3 percent to the total consumed, and the capture fisheries provide nearly 90 percent of domestically produced fish. Aquaculture provides 10-11 percent of the fish consumed, and most of that is milkfish. Finally, milkfish production generates economic benefits for several income groups and to society as a whole.

ANALYSIS

Aquaculture depends on several inputs: the cost and availability of land, labor, and money, fry or fingerlings, water, fertilizer, feeds, and management techniques. Villaluz (*46*) stated a commonly held perception, "Although most fishpond owners are well established financially, and most of them are among the richest in their provinces, very few, if any at all, have attempted to improve the practice and technology in fishpond management that they have inherited from their forefathers." Chong et al. (*13*) stated, "It is observed that most of the brackishwater ponds in the country have been developed haphazardly without the benefit of sound technical planning or engineering advice. Any person having access to a suitable piece of land can develop it into a fishpond." Thus, " . . . production costs are high and yields and net returns are low." The observations of Villaluz and Chong may have been accurate for the past, but strong evidence supports opposite trends for the present.

Accelerated fishpond development is a recent phenomenon; 42 percent of existing ponds were developed after 1966. Only 22 per-

Table 8. Area, Investment, Employment and Production of Brackishwater Fishponds, 1954-80

Year	Area, thousand ha	Invest-ments,[1] million P	Employ-ment,[2] thousands	Production	
				Thousand tons	kg/ha
1954	100.10	200.19	100.10	35.03	350
1959	119.58	239.16	119.58	58.09	486
1964	134.24	268.48	134.24	62.68	467
1969	164.41	328.83	154.41	94.57	575
1970	168.12	336.24	168.11	96.64	574
1971	171.45	342.89	171.45	97.92	571
1972	174.10	348.20	174.10	98.92	568
1973	176.03	1,056.19	176.03	99.60	566
1974	176.03	1,056.19	176.03	113.19	643
1975	176.03	1,056.19	176.03	106.46	605
1976	176.23	1,057.38	176.23	112.76	640
1977	176.23	1,057.38	176.23	115.76	657
1978	176.23	1,762.30	176.23	118.68	673
1979	176.23	1,762.30	176.23	133.60	758
1980	176.23	1,762.30	176.23	135.95	772

[1]Investment was based on the average development cost of P2,000/ha for 1954-72; P6,000/ha for 1973-77; and P10,000/ha for 1978-80.
[2]Assuming one person/ha.

cent of the ponds now in operation existed before 1955, and 27 percent of ponds now in use were developed from 1956 to 1966 (*25*). Although fishpond productivity is low, it has increased at the rate of about 5 percent per year for the past 25 years, table 8.

Expansion to Increase Production

Librero et al. (*26*) reported that in the early and mid-1970's the majority of fishpond operators wanted to expand their fish production area. Most of those who wanted to expand had small fish farms; only 45 percent of those with more than 50 hectares were interested in more farm area. The pond operators claimed expansion was constrained by lack of inputs: land, capital, manpower, fry, and fingerlings. In contrast to the desire to expand fish farming area, there is no direct interview information indicating that farmers wished to intensify production in existing ponds. Increases in fertilizer and pesticide use and in fry stocking rates suggest attempts to increase production through intensification, but Librero's (*28*) data from 1965-73 show that increases in production were attributable to increases in total area rather than from intensification.

A decade after the above information was collected, Chong et al. (*13*) interviewed 324 fishpond owners, 56 percent of whom wanted to expand their production area, but were constrained by lack of capital, technical assistance, availability of land, and time. Shortage of capital and land continued through the decade, but lack of manpower, fry, and fingerlings was no longer as important as the need for technical assistance and the time to manage increased operations. It is difficult to draw conclusions from this information, but it is believed that fry/fingerling distribution systems have improved, labor is more readily available, and fishpond operators have diversified sources of income.

Chong et al. (*13*), in a detailed study of milkfish production economics, hypothesized that variation in production could be explained by the following variables: pond age, number and size of milkfish stocked, fish acclimatization time before stocking, man-hours of hired labor, miscellaneous operating costs, operator's experience, pesticide use, organic and inorganic fertilizer use, and farm size. Their data were based on interviews with 324 producers in 7 provinces. It was biased toward the more progressive farmers since only producers who used inputs were interviewed. Their objective was to compare users of inputs to see which inputs affected production. The general conclusion was that because absolute values of the estimated production coefficients were low, the response of milkfish yields to supplemental inputs was low. However, they admit that the values they used as representative for other inputs could be improved in future research. This information contrasts with conclusions drawn by other researchers, particularly Librero et al. (*26,29*).

Chong et al. (*13*) found that variables were significant on a per hectare and per farm basis. Age of pond was significant as a result of the gradual build-up of organic material on the bottom and reduction of acid sulphate conditions through seasoning by draining, drying, and leaching. Milkfish fry stocking rates were significant, as were fingerling stocking rates, although slightly less so. Another significant factor was miscellaneous operating expenses which represented 22 percent of operating costs and was a catch-all for repair and maintenance costs, food for laborers, depreciation, rental, and interest. However, because the data were grouped, the possibility of one item being a useful indicator for production was masked.

Organic and inorganic fertilizer rates were significant although not greatly different. Chong et al. (*13*) concluded that these fertilizers were not used in large enough quantities to measurably affect yield. In contrast, earlier work by Librero et al. (*26*) showed that fertilized ponds averaged 832 kilograms per hectare per year versus 285 kilograms per hectare per year in unfertilized ponds. The conclusion was that fertilizer use increases production markedly, but these data may be misleading since farm size or other variables were not taken into account.

Farm size was significant according to Chong et al. (*13*), although there was a difference between privately owned and leased farms. Increased production was more affected by size on privately owned farms than on leased farms. In addition, economies of scale were positive, indicating that the average size farm (16.2 hectares) could increase profits by increasing level of inputs.

Chong et al. (*13*) also reported on a number of variables that were not significantly correlated with production. Acclimatization time for fry and fingerlings did not affect production. A better measure of the effect of acclimatization might have included temperature, salinity, or pH. That information was probably not available since they stated the "purpose and process of acclimatization is not clearly understood by the farmers." Hired labor was not significant because it was not a good measure of total labor, which also includes family labor. Number of years experience in milkfish farming was also not significant, and they concluded that "recent information in improved methods of production is, apparently, either not reaching the majority of milkfish producers, or not being adopted by them." Other factors that affect management are pond construction and layout, ability to control water, fertilization programs, and sources of marketing information. Application of pesticides had no statistically significant effect although fish farmers claimed the use of pesticides was important. Since all producers used about the same amount of pesticide, a significant correlation would be difficult to detect. Perhaps the type of pesticide ranked by known effect would have been a better measure. Librero et al. (*26*) stated that farms that used pesticides averaged 338 kilograms per hectare higher yield than farms not using pesticides, table 9.

Chong is completing research on "constraints to higher yields of milkfish farms in selected areas of the Philippines, 1981." That survey includes more detail on variables which were significant in the report summarized above, data on government loan programs, value and frequency of extension work contacts, full- versus part-time owners, and occupational history. The degree of vertical integration should also be measured as a possible variable in predicting pond production, because many pond owners are also fry concessionaires, dealers, and nursery pond operators, table 4.

Other correlations might also be examined. For example, Librero et al. (*26*) stated that fishpond operators with bigger fishponds tended to be more innovative in their operations. The question arises as to whether innovative people are attracted to big fishponds

TABLE 9. ANNUAL COSTS AND RETURNS PER HECTARE BY USE OF FERTILIZERS, BY REGION[1]

Item	Pesos/hectare, by region											Country average
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	
Did not use fertilizer												
Total receipts	3,471	2,275	1,186	1,243	1,199	2,390	622	1,205	778	1,258	1,550	1,270
Total expenses	1,258	533	846	896	510	1,164	468	459	354	480	1,166	646
Net return	2,213	1,742	340	347	689	1,226	154	746	424	778	384	624
Did use fertilizer												
Total receipts	3,650	1,750	2,843	1,870	922	3,032	1,157	1,521	599	1,854	2,510	2,668
Total expenses	1,860	920	1,998	1,091	474	2,046	722	738	323	873	1,704	1,755
Net return	1,790	830	836	779	448	986	435	783	276	981	806	913
Used organic fertilizer												
Total receipts	2,814	1,760	3,148	2,356	903	1,731	752	1,155	841	1,398	3,934	2,358
Total expenses	1,880	1,344	2,490	1,557	438	976	559	448	429	912	1,608	1,760
Net return	934	416	658	799	465	755	193	707	412	486	2,326	598
Used inorganic fertilizer												
Total receipts	3,742	2,856	2,550	1,263	1,019	3,118	1,318	1,556	476	1,698	2,331	2,628
Total expenses	1,803	1,865	1,522	545	598	1,706	869	767	308	606	1,604	1,473
Net returns	1,939	991	1,028	718	421	1,412	449	789	168	1,092	727	1,155
Used organic/inorganic fertilizer												
Total receipts	3,241	1,682	2,944	2,998	917	3,032	2,710	—	304	4,046	3,366	2,914
Total expenses	2,159	758	2,212	2,059	545	2,258	1,081	—	147	1,218	2,479	2,123
Net return	1,082	924	732	939	372	774	1,629	—	157	2,828	887	791
Average for all ponds												
Total receipts	3,625	1,816	2,517	1,683	1,031	3,008	1,026	1,293	701	1,364	2,394	2,294
Total expenses	1,782	873	1,776	1,032	486	2,015	659	536	339	549	1,637	1,458
Net return	1,843	943	741	651	545	993	367	757	362	815	757	836

From Librero et al. *(26)*.
[1]Region numbers with assigned provinces are given in Appendix A.

or whether the larger ponds force innovations to remain economically viable. This must be considered in light of another conclusion: highest net return per hectare was from farms in the 5- to 10-hectare range.

Two of the nonsignificant variables, pesticides and management practices, probably have significant impact on production even though the benefits were not observed in this research. The method of measuring the variables needs greater consideration in further attempts to correlate production with inputs.

An alternative to Chong's approach is to take a broader perspective of the effects of aquaculture development in the Philippines. This was done by combining the data from Librero (27), the Development Bank of the Philippines (DBP), and BFAR and analyzing fertilizer use, production, earnings, labor, number of extension workers, and bank loans provided by the DBP, table 10. A Pearson Correlation was performed; only data significant at $p > 0.05$ are discussed.

Fertilizer use was significantly correlated with gross but not with net earnings. The implication is that the cost of fertilizer is at least as high as the additional income generated. It was also found that a combination of organic and inorganic fertilizer increased where DBP loans were largest. Unfortunately, this information did not indicate whether the DBP policy was to make loans to farmers who knew how to fertilize or whether the loans provided the farmers with enough money to buy fertilizer.

A comparison of fish farm size to all other variables showed that size was directly related to gross and net earnings, and was negatively correlated with the time the owner spent working at the fishpond business. That is, owners of large farms spent smaller proportions of time at the fishpond business compared to the time spent by their caretakers. This also showed that a larger proportion of owner-to-caretaker time did not affect production (kilograms per hectare) or earnings. This is contrary to the comments made by fishpond operators.

TABLE 10. FERTILIZER USE, FARM SIZE, EARNINGS, LABOR, AND LOANS FOR 1975, BY REGION

Characteristic	Result, by region										
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI
Fertilizer used by more than 50% of farmers	yes	yes	yes	no	yes	yes	yes	no	no	no	yes
Predominant fertilizer[1]	inorg.	comb.	inorg.	comb.	org.	comb.	inorg.	inorg.	org.	org.	inorg.
Av. size of farm, ha	3.26	10.28	17.34	4.94	9.21	13.17	4.87	33.33	17.29	34.98	9.28
Av. kg/farm	2,307	3,402	10,608	2,323	2,391	11,888	1,407	10,613	2,921	13,988	4,769
Av. gross earnings/farm, pesos	15,318	18,646	52,634	9,834	11,082	49,279	5,723	46,520	13,376	53,066	28,393
Av. gross earnings/ha	3,625	1,816	2,517	1,618	1,031	3,009	1,025	1,292	701	1,363	2,394
Av. net earnings/farm	7,885	9,688	15,525	3,802	5,840	16,279	2,045	27,214	6,882	31,762	8,956
Av. net earnings/ha	1,843	994	742	651	544	994	367	755	361	816	756
Av. man days/ha/yr[2]	18.3	13.6	17.6	15.4	17.8	13.5	30.5	4.0	9.0	12.7	46.2
Pct. time spent by owner[3]	0.49	0.45	0.12	0.16	0.30	0.14	0.31	0.03	0.19	0.02	0.07
No. of extension and technical workers 1978	31	12	24	25	26	25	11	6	22	33	55
Total tons fish produced by aquaculture	6,525	134	21,486	14,736	3,745	39,692	2,884	3,175	6,912	3,962	3,209
Pesos (millions) loaned by DBP, 1976	1.369	1.488	1.784	17.941	1.080	26.890	1.389	0.420	1.149	1.535	2.773
No. of DBP loans	46	36	54	179	25	232	19	6	11	16	56

[1]Organic, inorganic, combination.
[2]Data for 1974.
[3]Percent of time spent by owner or owner + caretaker.

Production was positively correlated with the amount and number of loans given by the DBP, although net earnings were not. This would mean that government loans helped produce more fish, but did not improve the income of the operators. This could be an artifact of the distribution of DBP loans, because most loans are given in Region VI where the problem of marketing may have caused lower net incomes.

The number of extension workers was correlated only with the number of man-hours spent per hectare per year. From this, it could be hypothesized that extension workers have communicated information on the details of preparing fishponds, fertilizing, and similar activities. However, the number of extension workers may simply indicate government's interest in expanding fishpond production.

Serious questions have been raised regarding the accuracy of statistics on fishpond area, production, and yield. Fishpond area has remained constant through the years, and total production is estimated based on a survey of production per hectare per province done by the Bureau of Fisheries and Statistics in the late 1950's. Any inaccuracies in the area and production data are reflected in the yield per hectare. Also, these data are reported only on a national basis, which limits analysis to this level. Regional differences are difficult to analyze except from research done at different times in specific locations. Thus, systematic time series analysis on a regional basis cannot be done.

GOVERNMENTAL FACTORS

The Philippine National Development Plan estimates that fish production will expand at the rate of 5.6 percent per year from 1978 to 1982, thus increasing domestic fish supply from 1.6 million to almost 2 million metric tons. By 1987, fish supply must increase to 2.4 million tons. While municipal fisheries will still account for the majority of total fish production, the assumption is that coastal capture fisheries will increase at an annual rate of 4.6 percent per year, and aquaculture will expand at a rate of 9.8 percent per year. What is the probability of continued growth now that limitations on further development of mangrove areas exist? What is the potential for brackishwater production and freshwater production, and how is the government planning to maintain aquacultural production growth rates?

This section addresses the ability and commitment of the GRP to support aquacultural development as reflected in the quality and magnitude of support from service institutions and agencies, financial institutions, and external assistance organizations (e.g. AID).

Financial and Credit Institutions

After technical and economic feasibility of a project has been demonstrated, funding is usually the main constraint on the aquaculture industry in the Philippines. Current government loan programs are a long-term constraint to economic development of fishponds. The banks are inherently conservative. Their loans are limited to P25,000 to P30,000 per hectare, which is less than required in several regions where the cost of land, labor, and other inputs is high, for example in Capiz where P40,000 per hectare is needed. Government policy makers realized this problem and initiated steps to provide the needed financial support. The Development Bank of the Philippines (DBP) is the main source of credit for economic development of small-, medium-, and large-scale industries, including fisheries and aquaculture. The DBP acquires external funding from the World Bank, the Asian Development Bank, and other foreign loan sources. Government banks involved in fisheries and aquacultural development include the Central Bank and the Philippine National Bank. The former, through the widely scattered rural banks under its supervision, is to provide loans for small-scale fisheries and aquacultural ventures. The latter bank is also authorized to support selected fisheries and aquacultural projects. The Agriculture Credit Administration can provide funding for aquacultural projects through cooperatives. All these government credit institutions are supplemented by funding from private banks in the country. The World Bank loan through the DBP in support of brackishwater aquaculture expansion and intensification is considered successful. It has completed Phase I, implemented in 1972, which was a loan of $9.81 million. Phase II for $9.55 million, implemented in 1976, was completed in 1982. Plans are now underway for a Phase III (scheduled implementation in 1982) estimated at $18.4 million.

The Philippine Fish Marketing Authority is charged with coordinating and installing facilities for handling various fisheries products. It has a central national fish market with attached fishing port, and is in the process of establishing regional fish markets and fishing ports in strategic fish production areas of the country.

The National Food and Agriculture Council attached to the Ministry of Agriculture is charged with accelerating the production of food crops. Among its fisheries-related projects is the promotion of rice-fish culture using previously organized infrastructure under its Masagana 99 rice production sufficiency program. The Bureau of Cooperative Development, also under the Ministry of Agriculture, is charged with organization of cooperatives within the country. One of its targets is the development of producer cooperatives in fisheries and aquaculture, especially aimed at assisting the small producers. Although several initial projects have failed, there are a few successful examples which may become models for future development.

The Laguna Lake Development Authority (LLDA) is a regional development agency specifically charged with multiple use development of Laguna de Bay Lake, the biggest freshwater body in the Philippines. Besides looking into the water quality, industrial uses, water supply possibility, and fishing potential, the LLDA has also been responsible for stimulating development of the multimillion peso fishpen aquaculture industry in the lake. At present it administers and monitors this industry and is in the process of implementing financial assistance for the increase of small-scale fishpen projects. This is being done through an Asian Development Bank loan to the government.

Recent Government Programs

Two socially oriented government programs were recently initiated with heavy involvement in fisheries and aquaculture: (1) the Biyayang Dagat-79 credit program, and (2) Kilusang Kabuhayan at Kaunlaran program, commonly called KKK. Biyayang Dagat projects started in 1979 to provide credit to small producers with identified projects in target areas. It is also concerned with expanding and improving the extension service function of the BFAR. For aquaculture, there are loans for equipment, structures, and operating costs; freshwater species cultured in small ponds (from 1/2 to 1 hectare); and operating costs of brackishwater fishponds smaller than 10 hectares. Funds are distributed through the network of rural banks. For various reasons, this program has been only partially successful. The KKK program, begun in August 1981, is only in the implementation phase. It aims to stimulate economic and social development of the entire country by transforming the 42,000 villages into self-reliant productive communities. The method is the establishment of livelihood projects that are owned and managed by the community residents. The projects are in such fields as agroforestry, agrolivestock, waste utilization, cottage and light project industries, shelter materials, and aquaculture. Possible aquacultural projects include communal fishfarm estates (using ponds, pens, or cages), communal fish hatcheries, and seafarming of oysters, seaweed, and mussels. Priority beneficiaries include landless workers, subsistence fishermen, urban slum dwellers, minorities, out-of-school youths, and disabled persons. Local officials assist in the program, and the national extension services also take active part. KKK project recipients receive technical and marketing training, infrastructure support, and assistance in project development and management. The program has strong government support as reflected in the fact that the national committee is of the highest level and includes a national secretariat.

Support Services for Aquacultural Development

Other government agencies provide full or partial support for aquacultural development. The number has increased over the years, but some date back to the 1930's. For example, prior to World War II the government established the National Foods Corporation as a subsidiary of the National Development Company. The aim was to develop a large brackishwater fishpond project to demonstrate the commercial operation of a vertically integrated venture. It included a few hundred hectares of fishponds, equipment and facilities to process the products, and the machinery to market, handle, and distribute the processed goods. After a few years of operation, some of the facilities were destroyed during World War II and others deteriorated. Although results were initially encouraging, the project was abandoned after the war and the ponds reverted to private use.

PUBLIC SERVICE INSTITUTIONS

In recent years many technological, social, and economic changes have encouraged Philippine fish farmers to intensify fish production efforts. This section describes the major changes that have occurred in public institutions during the evolution of the aquaculture industry. These institutions are grouped here in four categories: administrative, educational, research, and extension.

Administrative Institutions

Administrative institutions in aquaculture plan and set policy, provide support or financing, and fix laws or regulations related to aquacultural production. Administrative programs may bear directly on the production sector or may be indirectly involved, such as with development of public works, markets, credit, and overall aquaculture programs.

Historical reports maintain certain forms of aquaculture existed in the Philippines during the early 16th century. Actual practices probably began in the early 15th century. However, there are no records of specialized government fisheries institutions charged with administering or managing this type of economic activity during the Spanish era (1521-1898). The only records available on fisheries during that period include scattered reports of specific resource surveys and taxonomic reports.

Agencies were first charged with fisheries responsibilities during the United States regime (1900-1946). One policy was to develop the country's fishery resources. Consequently, in 1907 a Fisheries Section was organized in the then Bureau of Government Laboratories, staffed by only one person (an expatriate named Alvin Seale). The U.S. government dispatched the research vessel *Albatross* for an oceanographic and fishery resource survey during 1907-10.

The Bureau of Government Laboratories was later expanded and reorganized into the Bureau of Science, which included a Division of Fisheries. On January 1, 1933, the Division was enlarged into a Fish and Game Administration. This was formed by fusion of the Division of Forest Fauna and Grazing under the Bureau of Forestry with the Divisions of Fisheries and Zoology of the Bureau of Science. Administration was placed directly under the Department of Agriculture and Commerce. On September 27, 1934, the Fish and Game Administration was returned to the Bureau of Science. On July 1, 1939, a new Division of Fisheries in the Department of Agriculture and Commerce was organized by returning Forest Fauna and Grazing to the Bureau of Forestry and Zoology to the Bureau of Science.

During World War II Japan occupied the Philippines from 1942 to 1945. During the early part of the Japanese Period, a Bureau of Forestry and Fishery was created (1942-43). In 1944 fisheries functions were assigned to a separate office called Bureau of Fisheries. After the war, under American Commonwealth rule, the old Division of Fisheries was restored to the Department of Agriculture and Commerce, reorganized as the Department of Agriculture and Natural Resources (DANR). Philippine independent rule started in 1946 with most of the established administrative offices, including fisheries, being continued during the transition period.

An enlarged Bureau of Fisheries (BOF) was organized by Republic Act No. 177 on July 1, 1947. By this time the expanded Bureau included the Philippine Institute of Fisheries Technology and seven secondary fisheries schools. Later, on January 16, 1957, the educational functions of the Bureau of Fisheries were transferred to other offices. The Institute of Fisheries Technology was transferred to the University of the Philippines (UP) and became the UP College of Fisheries (UPCF). The fisheries secondary schools, of which an additional seven were added, were transferred to the Bureau of Public Schools in the Department of Education.

In 1963, the Bureau of Fisheries was converted into the Philippine Fisheries Commission within the Department of Agriculture and Natural Resources, and in 1972 they reverted to the old name, Bureau of Fisheries. In 1974, with a shift from a presidential to a quasi-parliamentary government, the various cabinet rank departments were converted into ministries. Agriculture and Natural Resources was divided into two ministries: a Ministry of Agriculture (MOA) and a Ministry of Natural Resources (MNR). The Bureau of Fisheries was again reorganized into the Bureau of Fisheries and Aquatic Resources (BFAR) under the MNR with the Office of the Minister responsible for fisheries policies. It remains known as BFAR to date.

During the period the fisheries office was at the division level, a section, variously named Fish Culture/Inland Fisheries/Fisheries Biology and Conservation, was responsible for aquaculture. By 1980, BFAR consisted of 14 divisions plus 13 regional fisheries offices. The divisions are: Administration, Finance, Planning and Management, Legal, Fisheries Training, Fisheries Conservation and Enforcement, Fisheries Utilization, Fisheries Economics and Information, Technological Services, Fisheries Licenses, Fish Propagation, Fisheries Research, Fisheries Extension, and Fisheries Engineering. Of these, the Fish Propagation Division has full involvement in aquaculture while Fisheries Training, Fisheries Economics and Information, Fisheries Research, and Fisheries Extension have partial responsibility for aquaculture. The different Fisheries Regional Offices are involved in aquaculture and may have specific units for aquaculture.

Fisheries policies are formulated through the Fishery Industry Development Council, an agency under the MNR. The Development Council, in consultation with the Office of the Minister and BFAR, formulates the plans and programs of fisheries development for the country, while BFAR is the implementing agency.

Fisheries programs are incorporated in the "National Economic Development Plan," which includes both a medium-term (5-year) and long-term plan. The National Economic Development Authority assembles the various programs of the different agencies of the government into a national economic development program. It oversees and monitors the implementation of this program by the different government agencies. It also coordinates all external inputs.

Educational Institutions

Fish farming in the Philippines was three centuries old before formal education and training in fisheries were first begun. The first recorded training specifically on fisheries biology was started in the UP College of Agriculture in the late 1920's.

The following excerpt from Mane (32) describes early training development in fisheries:

"College training in fisheries work was initiated in the Philippines at the College of Agriculture, University of the Philippines. In 1924 a member of the teaching staff of the College, Deogracias V. Villadolid, B. Agr., B.S.A., was sent to the United States for 3 years as a fellow at the University of the Philippines for advanced training in zoology and fisheries at Stanford University. Upon his return in 1927 he worked for the inclusion of fisheries subjects in the curriculum of the College of Agriculture. Finally, in 1930, the College established the Limnological Station on the shores of Laguna de Bay at Mayondon, Los Banos, Laguna Province and included in its curriculum a course on 'Introductory Economic Ichthyology' under agricultural zoology. Students majoring in agricultural zoology with thesis problems in freshwater fisheries biology were required to take this course. These students became the pioneers in research work in fisheries biology in this country.

"Some outstanding achievements of the fisheries training in the College of Agriculture were the publication of important facts obtained from researchers on ecology, life history and biology of some of the most important aquatic fauna of Laguna de Bay, and the training of a number of students later to become outstanding fisheries workers in the Philippines.

"In 1936 the College of Liberal Arts of the University of the Philippines offered a four-year course leading to the degree of Bachelor of Science in Fisheries. The course was intended to turn out graduates who would be competent to do research work in fisheries biology and systematic ichthyology. Theoretical training was also given on the methods of fish capture, fish preservation and fish culture . . ."

About 10 students started the first fisheries course, 6 of which graduated in 1940. The program was then interrupted by World War II.

Mane was among Dr. Villadolid's first students in 1927, which also included F. Alonte, F. Arriola, D. Bunos, P. Manacop, A. Nono, and others. The initial few agricultural graduates who majored in fisheries later became the primary staff in planning and implementing national fishery programs. Other Filipinos received foreign training in fisheries during the 1920's, including H. Montalban, F. Talavera, J. Montilla, G. Ablan, and G. Blanco.

In 1936 when the UP College of Liberal Arts in the Manila campus started courses toward a Bachelor of Science in fisheries, the curriculum included major options such as fishing methods, fish culture, and fish preservation. The six original graduates were divided among the majors. After a short interruption at the outbreak of World War II, the UP resumed classes during the Japanese occupation, and after independence the baccalaureate course in fisheries allowed previously enrolled students to graduate but no new students were admitted because of inadequate funds and lack of facilities. A total of 18 persons graduated from the program.

The Philippine School of Fisheries was established in 1944 within the old Bureau of Fisheries at Navotas, Rizal, near Manila. It operated for only about 3 months before closing as a result of increased intensity of the war. The school was reopened in 1946 offering 2 1/2-year practical curricula in fish capture, fish culture, and fish preservation. It also offered practical opportunity courses for an unspecified period based on the desire of the registrant. The school was later renamed Philippine Institute of Fisheries Technology so that it could be retained in the Bureau of Fisheries as a training institute rather than a school in the Department of Education. It offered college-level instruction to graduates of recognized high schools, and had 40-50 students enrolled each year. Students in the Institute were generally of normal ability, choosing the tuition-free school because of low cost and employment opportunities upon graduation. The fish culture course was practically oriented, and used the Bureau of Fisheries experimental farm at nearby Dagatdagatan lagoon for laboratory work. Course requirements in fish culture included a 6-month practicum at a commercial fish farm or similar experience. About 15 students, mostly males, were in each class. Graduates were generally employed in the Bureau or in one of the regional or vocational fisheries schools, but a few went to family-owned or other private fish farms or left the fishery sector completely.

REGIONAL AND VOCATIONAL SCHOOLS. In 1949, seven fisheries vocational schools opened under the Bureau of Fisheries in Catbalogan (Samar Province), Tabaco (Albay Province), Daanbantayan (Cebu Province), Tibiao (Antique Province), Zamboanga (Zamboanga Province), Estancia (Iloilo Province), and Nasugbu (Batangas Province). In 1957, the Bureau was reorganized, and the secondary fisheries schools, which by then had increased to 14, were transferred to the Bureau of Public Schools in the Department of Education. At this time the Institute of Fisheries Technology was also transferred to the UP to become, in 1959, the UP College of Fisheries (UPCF) in Diliman, Quezon City. Additional secondary fisheries schools were established, and others were upgraded to become regional fisheries colleges (e.g. Zsmboanga and Tabaco). By 1977 there were five such programs offering degrees or diplomas (post secondary training) with a total enrollment of 1,500 students. Although facilities for fisheries education have expanded consistently since World War II, it is doubtful whether much training deals with aquaculture. In the early 1970's, education and training were consolidated and upgraded under the Educational Development Projects Implementing Task Force (EDPITAF). All levels of fisheries education and training have been included in this program. A system of fishery secondary schools developed across the country, and in 1975 all secondary schools adopted the same core curriculum recommended by a national task force. By 1977 there were almost 70 fishery secondary schools with a total enrollment of 20,000 students. They used a common comprehensive national curriculum, with fishery subjects being covered during practical arts, which amounted to about 10 percent of the overall learning time.

UP COLLEGE OF FISHERIES. The UPCF started 2½-year diploma courses in 1957, and added a 4-year B.S. in fisheries, with majors in marine fisheries, inland fisheries, and fish processing technology. In 1980, the Diliman campus, with an Inland Fisheries faculty of 13, had 140 students enrolled in the fish culture diploma course and 100 students in the B.S. major in inland fisheries course. In 1974, with establishment of the UPCF Brackishwater Aquaculture Center (BAC) in Leganes, Iloilo, the UPCF-BAC and the UP Iloilo campus initiated a joint B.S. fisheries degree program. By the first semester 1980-81, 47 undergraduate students were enrolled in this program. A graduate study program for the M.S. in fisheries, major in aquaculture, also began in the second semester of the 1974-75 school year, built particularly upon the resources available at the BAC (with linkages to the Freshwater Aquaculture Center at Central Luzon State University) and, since 1976, with formal collaboration with the Southeast Asian Fisheries Development Center (SEAFDEC) Aquaculture Department. A nonthesis Master of Aquaculture program has also recently been added by the UPCF. Currently, UP programs in the Iloilo area are being consolidated into a new unit called the UP Visayas (UPV). A new campus headquartered at Miag-ao, Iloilo, will include the BAC and the UP Iloilo College of Arts and Sciences, and will focus on fishery training. The UPCF is scheduled to move to Miag-ao by mid-1983, but there is some resistance to this move. Counter proposals are being suggested by staff in Diliman. The new campus development is financed as part of the World Bank loan through the EDPITAF program for fisheries education development. The current graduate faculty at the BAC (Brackishwater Aquaculture Center), including those from SEAFDEC on full or affiliate appointment, numbers 20. Graduate student enrollment for 1981-82 is 52 students, 23 of which are female, 17 foreign-sponsored, and 32 receiving domestic support (principally from the Philippine Council for Agriculture and Resources Research and Development). Shuttle transportation is provided to the BAC or SEAFDEC training sites from Iloilo City. Tuition for the M.S. fisheries students is P468.50 per semester (approximately $57). From the first graduate in October 1977 to December 31, 1982, 44 thesis research projects have been completed in the M.S. program: 17 by females and 5 by foreign students (3 from Indonesia and 2 from Nigeria).

CENTRAL LUZON STATE UNIVERSITY. With the establishment of the Freshwater Aquaculture Center (FAC) at Central Luzon State University (CLSU) in 1972, fish farming subjects were incorporated into the general agricultural B.S. curriculum. This led to the creation of a department which now is the College of Inland Fisheries with a faculty of 11 that offers B.S. and M.S. degrees. Enrollment in the B.S. program has been growing: 162 were enrolled in 1978-79 and 233 in 1980-81. This contrasts with a decline in enrollment in the common first year for all undergraduate programs from 1,418 to 845, a trend also seen in other state colleges and universities in agriculture. Major contributing factors to this downward trend, also likely to affect future student representation in fisheries, are "(1) inflation and high cost of transportation; (2) the shift in the demand for nonagricultural graduates particularly in the Middle East; (3) the proliferation of state and private agricultural schools in nearby provinces; and (4) the regional and national manpower needs in agriculture have almost been attained" (*11*).

OTHER SCHOOLS. In 1978-79, partly as preparation for a World Bank loan for fisheries education development, the overall public higher education program in fisheries was reorganized. Under the plan, the University of the Philippines Visayas (UPV) was created with a fisheries program intended to be "the apex national fishery training program" as well as to serve the higher educational needs in fisheries for the central Philippines. Central Luzon State University was to continue as the regional fishery school for Luzon, and Mindanao State University was to serve the southern region. The UPV was to phase out the 2-year diploma program and to shore up its capabilities in all aspects of fisheries and marine science. The national colleges of fisheries will offer undergraduate and graduate curricula in fisheries to provide core staff for research and faculty.

As a second level of higher education, seven Regional Institutes of Fishery Technology have been identified to give technical post-secondary diploma courses and phase out their B.S. fisheries programs if already established. The plan presumably also calls for phasing out fishery programs in other regional technical colleges. Regional Institutes for training extension workers and technicians for various industries in fisheries and aquaculture are:

Cagayan State University College of Fisheries
Aparri, Cagayan (Region II)

Palawan National Agricultural College
Puerto Princesa, Palawan (Region IV)

Bicol University College of Fisheries
Tabaco, Albay (Region V)

Quirino School of Fisheries
Carmen, Cebu (Region VII)

Samar Regional Fisheries Technical School
Catabalogan, Samar (Region VIII)

Mindanao Regional School of Fisheries
Zamboanga, Zamboanga del Sur (Region IX)

Davao del Norte School of Fisheries
Panabo, Davao del Norte (Region XI)

Enrollment for 1981-82 was 2,850, with 940 specializing in inland fisheries. In addition, seven Regional Fishermen's Training Centers will provide a third level of education by offering practical training for fishermen and fish farmers. Development of both Regional Institutes and Training Centers is implemented under the EDPITAF with funds from the World Bank loan.

DISCUSSION. The GOP commitment to fisheries education is appropriate given the importance of fish and fishing in the country. Filipino families are generally willing to make considerable sacrifice to educate their children. Education gives social status, higher income, and may result in increased family security. A certificate or diploma, followed by an appropriate job, is the desired end of the process. Fisheries education has been relatively inexpensive, and, at least in the case of the UPCF until recent years, had low admission standards. This means that students of limited financial resources (such as girls in families where first priority in education goes to the boys) or of marginal academic ability have gravitated into fisheries courses. This would explain, in part, the high proportion of females enrolled in fisheries courses.

Graduates in fish culture have not been particularly sought after by the private sector. Many private producers contend that "costly school-learned techniques" are inferior to their own current practices, and they stigmatize recent graduates as being ill-trained. The same stigma carried over to graduates who found employment in extension work. Those in education tended to teach what they had learned, so there was little infusion of new ideas or relationship of the subject matter to what was marketable in the private economy. The few graduates with exceptional ability or good fortune who received postgraduate or other advanced training have been in demand because of expansion of educational and other public sector programs. They generally have moved into administrative positions.

The recent development of educational programs in fish culture at the UPCF and CLSU appears to be a by-product of the development of research programs at the Brackishwater Aquaculture Center, the Freshwater Aquaculture Center, and SEAFDEC. The new research programs required a faculty to staff academic programs. The high-level training and research activities of the staff provided a new infusion of information valuable to the private sector. Graduate students provide much of the manpower used in the daily operation of research projects. Thus we conclude that a vital research program is a key to a quality fish culture educational program.

Nonacademic use of the more progressive fish culture educational programs seems to be good. The schools have participated in a number of special training programs for vocational school teachers, farmer extension programs, KKK programs, and others. The applications from foreign students also suggest an importance beyond national boundaries.

Research Institutions

Early aquatic research in the Philippines was confined to taxonomic and observational reports. The most prolific publisher was A. Herre, an American working at the Bureau of Science in Manila, who published more than 100 scientific and popular papers on ichthyology and related topics in the period 1921 to 1948. His description of the milkfish culture system (*21*) stands as a benchmark for the state of the industry at that time. Other descriptions followed in later years by Adams et al. (*1*), Carbine (*12*), and Bardach et al. (*6*). The Bureau of Fisheries had the early responsibility for applied research. It opened an oyster demonstration farm in Bacoor Bay, Binakaya, Kawit, Cavite Province, in 1935 to test various methods of setting and rearing oysters in Manila Bay. The farm is still in operation but is likely to close because of reclamation activity in the Bay. A freshwater hatchery was also established on the shores of Laguna de Bay at Tanay, Rizal, in 1939.

Research on milkfish pond culture started with the opening of the

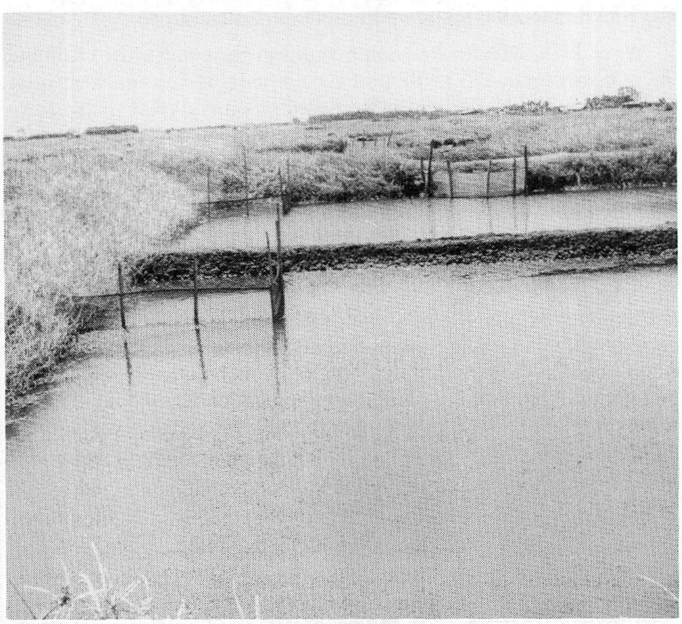
Dagatdagatan Salt-Water Fishery Experiment Station at Dagat-Dagatan Lagoon, Malabon, Navotas, Rizal Province, in 1938. The station had an area of 10 hectares plus about 5 hectares of adjacent leased pond area. Researchers investigated stocking rates, fertilization, feeding, and species combinations. Urban encroachment resulted in siltation and pollution of the waters so the station was closed in the mid 1970's. The succession of directors of the station include D. K. Villaluz, Pedro Acosta, H. Rabanal, R. Esguerra, and I. A. Ronquillo, all of whom have been active in subsequent aquacultural development activities in the Philippines.

In the 1950's, the Bureau of Fisheries began establishing a network of fish culture demonstration and training stations around the country. There are currently about 40 brackishwater, 31 freshwater, and several sea farming trial sites. Research was originally conducted at these units, but little has been published.

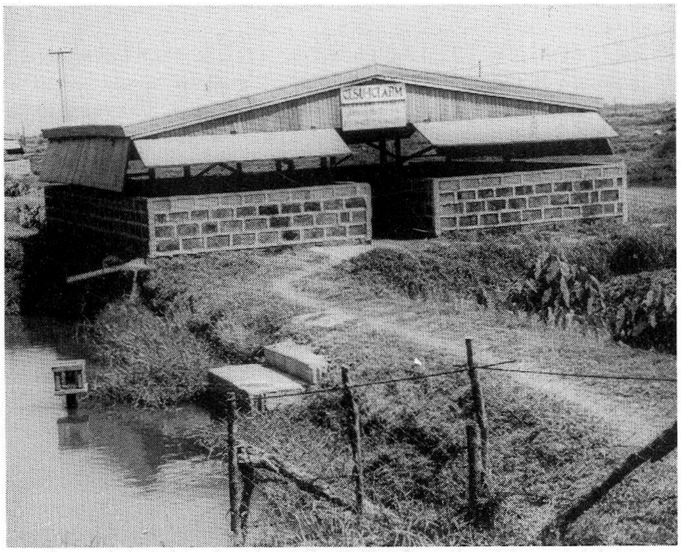
Some basic biological research was conducted during the 1950's and 1960's at the universities and in public agencies. UPCF established the Institute of Fisheries Development and Research. Mindanao State University conducted some shrimp culture research in the late 1960's. The Laguna Lake Development Authority concentrated on biological studies, gathering statistical information about lake fisheries and describing a variety of fish product uses.

In 1971, the Philippine Government initiated serious research in pond aquaculture. This led to the creation of the Inland Fisheries Project, a program to build both a brackishwater and freshwater pond and laboratory research stations. The National Science Development Board provided most local financing, and USAID funded overseas staff training, equipment purchase, and technical assistance. Because of the emphasis on research, the UPCF, through its Institute of Fisheries Development and Research, was designated the overall implementing agency, with CLSU as a partner in the establishment of the freshwater station. The research stations were officially designated in the mid 1970's as the Brackishwater Aquaculture Center (BAC) under the UPCF and the Freshwater Aquaculture Center (FAC) under CLSU.

BRACKISHWATER AQUACULTURE CENTER. With the support of an enthusiastic group of local fishpond operators, the municipality of Leganes in Iloilo Province provided 50 hectares of municipal-owned traditional brackishwater fishpond land to the Inland Fisheries Project for development of the brackishwater research station. Initial construction involved modest laboratory structures and excavation and diking of the land into series of small research ponds. In spite of difficulties, the station now has a complex of support buildings and dozens of operational ponds for experimentation. The BAC has become an autonomous operational unit within the new UPV and is fully integrated with the UPCF-SEAFDEC graduate program in aquaculture. Staff generally have joint responsibilities in teaching and administration. The BAC receives a direct line-item appropriation in the national budget (P855,000 in 1981). There are also research projects with special funding in four main areas: culture systems, fry and fingerling survival, use of agricultural by-products, and acid-sulfate soils. They also have special programs for pesticides, energy, parasites, and diseases, and hope to include fish breeding and genetics.



Research at the Brackishwater Aquaculture Center has made progress in combating acid soil conditions and in establishing vegetative cover for dikes.



Research in integrated animal and fish production at Central Luzon State University.

FRESHWATER AQUACULTURE CENTER. The location of the freshwater station under the Inland Fisheries Project at CLSU resulted principally from the willingness of President Fernando Campos to provide land for the station within the University farm area and to join with the UPCF in developing the station. Earlier attempts to locate on Mindanao were frustrated by the distance from Manila and the questionable security there. The initial station, with 60 small research ponds (100- and 500-square-meter) and a laboratory building, was inaugurated in 1973. Since then, additional ponds, buildings, and a rice-fish experimental area were developed. The FAC is now fully operated by CLSU with staff generally sharing appointments with the academic College of Inland Fisheries.

SOUTHEAST ASIAN FISHERIES DEVELOPMENT CENTER (SEAFDEC). In 1974, the regional SEAFDEC Aquaculture Department was established in the Philippines. The original thrust of SEAFDEC was to be in shrimp production research principally with assistance of the Japanese government with Mindanao State University as lead counterpart. A 10-hectare site adjacent to the Inland Fisheries Project site in Leganes, Iloilo, was reserved, and land on the coast of Tigbauan, west of Iloilo City, was secured for development of an expansive research and training facility. Additional land was also leased at Leganes for construction of more ponds and support buildings. Besides work on the biology and cultivation of shrimp, the Aquaculture Department has worked on the reproduction of milkfish and a variety of other research projects with crustaceans, molluscs, and finfish. A number of substations, including a freshwater research center at Binangonan on Laguna de Bay, have been established. They are now independent of Mindanao State University but have an agreement for cooperative training with the UPCF.

MINDANAO STATE UNIVERSITY. This university operates the Institute of Fisheries Research and Development at Naawan, Misamis Oriental. The Institute attracted some attention in 1969 with the successful reproduction of the shrimp *Penaeus monodon* under laboratory conditions. The Aquaculture Department of the Institute has several modest projects dealing with development of hatchery technology, feeds, pond culture techniques, and parasite and disease identification with particular emphasis on marine crustaceans and molluscs. The department is led by three research associates with M.S. degrees.

PHILIPPINE COUNCIL FOR AGRICULTURAL RESOURCES RESEARCH DEVELOPMENT. In November 1972, the Philippine Council for Agricultural Research was created by presidential decree as a central coordinating agency attached to the National Science Development Board for approval of all governmentally sponsored agricultural research. The scope of the council was subsequently expanded to include mining resources, and the name was amended twice to what is currently the Philippine Council for Agriculture and Resources Research and Development (PCARRD). The Council not only approves, but also helps plan, fund, develop capacity, and publish research activities. Its secretariat at Los Banos operates under policies set by a governing council and an advisory technical program planning and review board. For each major subject area under its jurisdiction, a commodity team of local researchers serves part-time to plan, coordinate, review, and evaluate research programs in their respective areas. There are separate fisheries commodity teams for marine fisheries, aquaculture, and inland fisheries.

Priorities for aquacultural research, including socio-economic and biological topics, have been developed and updated through national workshops convened for this purpose. Where needed, the Council can commission research to address these priorities or provide scholarships to generate research skills related to priorities.

For the period 1973-81, the Council lists 283 completed projects in aquaculture in different disciplines by different agencies, and there are approximately 85 ongoing projects approved beyond 1981 (*36*). Budget requirements for all approved aquaculture projects from all sources in 1981 totaled approximately P4.5 million. About 40 percent of the total was from the Council's budget, 29 percent from the National Science Development Board, 16 percent directly from implementing school budgets, 6 percent from BFAR, 5 percent from the Natural Resource Management Center, and 4 percent from the Bureau of Agricultural Economics (BAEcon). Of the combined NSDB-PCARRD budget for aquacultural research projects in 1981, 51 percent went to CLSU, 29 percent to the UP System, and 18 percent to other institutions to fund projects on the culture of seaweed and the controlled breeding of migratory fishes in Naujan lake. To develop research capabilities in the national research network, the Council provides scholarships for B.S., M.S., and Ph.D. degrees in aquaculture and related fields.

DISCUSSION. The research facilities for aquaculture built over the past decade are certainly impressive. Physical facilities should not be a limiting factor for research in the foreseeable future. Library facilities to support research in aquaculture are rather limited, but in a field of rapidly evolving technology, extensive historical holdings are not as important as in some disciplines. The need for support to maintain and operate research facilities and research libraries should be recognized before further physical expansion of research facilities is contemplated.

Workshops, seminars, and other meetings sponsored by organizations such as PCARRD (Philippine Council for Agriculture Resources Research Development), SEAFDEC, the International Center for Living Aquatic Resource Management (ICLARM), and the Food and Agriculture Organization of the UN provide avenues for disseminating research findings. Their respective newsletters and publications have facilitated a considerable information exchange between researchers, program administrators, and the private sector.

The Fisheries Research Society of the Philippines started in 1976 with 114 charter and active members. By 1979 it had grown to 334 members, about one-third of which considered aquaculture as their special interest. The Society has already published five volumes of a semi-annual journal, the Fisheries Research Journal of the Philippines.

A major problem in aquaculture research and development has been the lack of well-trained leaders, particularly at the Ph.D. level. This concern was expressed at each of the research centers visited (CLSU, UPV, and SEAFDEC). A major cause has been the rapid growth of the centers. The problem is worsened by low pay scales at the universities and in government compared to high-paying consultancies at home and abroad. Funding agencies have countered with honoraria for specific research projects, but this has not been adequate. The trend is toward research in absentia, with project leaders delegating most of the work to poorly directed or unqualified technicians or students. There also appears to be a proliferation of small projects with minimal reporting of results. Obviously, this pattern is not unique to aquaculture or to the Philippines, but it is of real concern when considering the quality of future aquaculture research.

Extension Institutions

Extension, the process of informal education by which technology is diffused beyond the classroom, is a primary function of the Bureau of Fisheries and Aquatic Resources. A major division within the BFAR is the Extension Division within the central office and each regional office. The following excerpt from the FIDC Integrated Fisheries Development Plan for the 1980's (*17*) gives an indication of the BFAR extension scope and mission in aquaculture:

"As of 1979, BFAR extension manpower for aquaculture is about 267. Of this total, 218 or 82 percent are assigned to brackishwater fishponds, 33 or 12 percent to freshwater fishponds and the remaining 16 or 6 percent to seafarming (mussel and oyster culture). At present, an extension worker for brackishwater fishponds services an average area of 800 hectares. Such a wide area coverage naturally will result in poor technology transfer. To accelerate effective dissemination of technology, additional extension workers need to be recruited within the five-year period 1981-1985. On the assumption that an extension worker can effectively service a maximum area of 200 hectares, a total of 678 extension workers should be recruited for existing areas and 50 for the newly developed areas. The 39 extension workers who are assumed to be excess in their respective provinces would be re-assigned in provinces which lack enough extension workers . . . . . Intensive training of all extension workers on culture of new species, especially tilapia and shellfish, is necessary to support the development plan . . . .

"Extension services that will be provided will include the following:

a) Technical assistance in the construction, operation and maintenance of fishponds, fishpens and fishcages.

b) Technical assistance in the preparation of fisheries project feasibility studies and in their implementation.

c) Conduct lectures, seminars and workshops on aquaculture techniques.

d) Demonstration on proper handling, storage, transport of fish and on the various processing technologies such as drying, salting, smoking, deboning, etc."

BFAR has many programs associated with aquaculture extension. The operation of the aforementioned 70+ demonstration fish farms/hatcheries/seed banks is an example. BFAR also sponsors an annual Fish Conservation Week in October in which special posters, publications, and other communication media are directed to fishery affairs. Extension agents are assigned to the Development Bank of the Philippines in 11 regions of the country to assist in the preparation of loan requests and to provide technical assistance to borrowers who have secured loans for fish pond development. Similar support services are available to borrowers under the Biyayang Dagat Program in which short-term loans for aquacultural production may be obtained from one of 125 participating rural banks, the Development Bank of the Philippines, or the Philippine National Bank. A variety of donor assistance projects has also helped the BFAR aquaculture extension effort: the FAO-sponsored Brackishwater Aquaculture Development and Training Project, the USAID-assisted Freshwater Fisheries Development and Aquaculture Production Projects, the World Bank/EDPITAF Fisheries Training Project, the U.S. Peace Corps Fishery Volunteer Program, and Japanese Overseers Cooperative Volunteer Program are the most significant recent projects.

Several other agencies have functions that overlap BFAR aquaculture extension. For example, the Laguna Lake Development Authority has jurisdiction over the fishery resources of Laguna de Bay, including the fish pens and cages. This includes a large project funded by the Asian Development Bank to finance small-holder entry into the pen/cage business. PCARRD publishes extension literature, such as the *Philippines Recommends* series on milkfish, oyster, mussel, and tilapia culture and the *Technology* series on rice-fish culture and the culture of seaweed. The Ministry of Agriculture has a National Food and Agricultural Council for rice-fish culture and lends extension support in programs using water, animal feeds, farm credit, fertilizers, and pesticides directly linked to aquaculture. All three major universities with aquaculture programs, UPV, CLSU, and MSU, have extension responsibilities, and MSU also offers a B.S. fisheries degree with a major in extension.

There are several fish producer associations which provide information exchange. Probably most notable of these is the group in Iloilo that has operated successfully for more than 20 years and now holds training programs for caretakers and small-scale fishpond operators. The Iloilo and other such groups are now united in a regional and national federation of private producers with an annual conference on technical and political matters influencing the aquacultural industry.

Some of the extension workers of the BFAR have been uninterested or unable to move about in the field. Even those with technical training in production techniques and extension methodology do not have adequate educational materials or budgets. The progressive fish farmers generally considered themselves better informed than their seldom-seen and inadequately prepared fisheries extension workers.

Nevertheless, there has been some positive impact of extension. For example, foreign advisors used in training by the BFAR have provided credibility to the use of fertilizers, proper pond layout and construction, care in the handling of fish, and other management techniques. Peace Corps Volunteers have given vitality to extension activity. The recent growth of seaweed culture, tilapia production, pen and cage culture, and rice-fish combinations has certainly been facilitated by extension programs. Research programs of FAC, BAC, and SEAFDEC have also provided worthwhile information to extension workers for transfer to small and new aquaculture entrepreneurs.

EXTERNAL ASSISTANCE

Although aquaculture has been practiced in the Philippines for centuries, it is only within recent years that significant improvement in culture techniques has been attained. One reason for such progress is the assistance provided by outside agencies and donors, including the United Nations and its family of agencies, established international and regional institutions, and bilateral donors. All are concerned with technical assistance, which can be technical advisors, commodities, equipment, and/or training. The second type of assistance is funding or credit, generally from the World Bank or from regional banks such as the Asian Development Bank.

Technical Assistance from United Nations Agencies

The Food and Agriculture Organization (FAO) of the UN supports fisheries and aquacultural development with funds from the UN Development Programme or other sources. For example, projects involving aquaculture may be sponsored directly from UN headquarters through the Laguna Lake Development Authority, an agency which has provided assistance to the Philippines for over two decades. The United Nations Educational Scientific and Cultural Organization (UNESCO) supports research or training programs in fisheries, aquatic resources, or aquaculture. The United Nations Children's Emergency Fund, through its Applied Nutrition Program, has also assisted in the production of food fish. The World Food Program, using food commodities as means of assistance, supported the development of freshwater fish culture in the Candaba swamp, Pampanga Province, from 1969 to 1971.

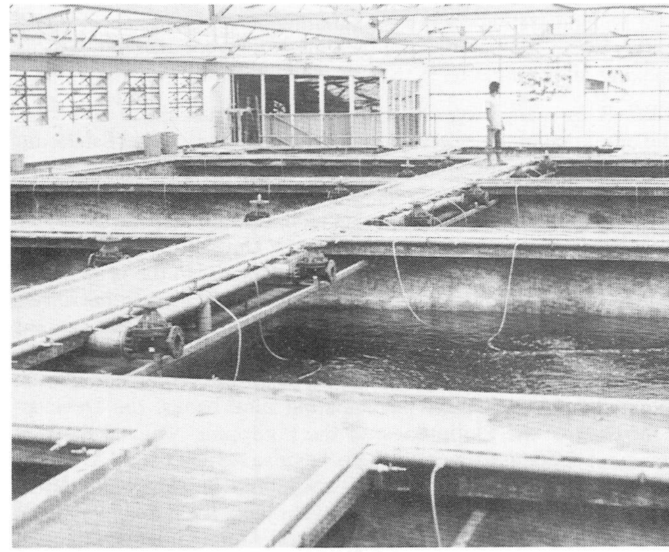
The FAO has long assisted aquacultural development in the Philippines. A limnology project (Freshwater Fisheries Investigations) was implemented from 1964 to 1966. This was followed by a fish culture development project from 1967 to 1970 to stimulate the improvement of culture techniques for brackishwater fishponds. Overlapping this project was the Freshwater Fish Culture Project (1969 to 1971) which was supplemented by the World Food Program project mentioned above. The Brackishwater Aquaculture Development and Training Project was implemented in 1978 by FAO with UNDP funding. This project, which terminated in December 1982, provided technical assistance, commodity and in-country training services, and established four demonstration stations in each climatic zone of the Philippines. Manuals for training and extension have been developed, and both new and existing extension workers were trained or upgraded.

FAO is also involved in regional and interregional aquaculture projects. The South China Sea Fisheries Development and Coordinating Programme has an aquaculture component. The Interregional Aquaculture Development Coordination Program supports a project known as the Network of Aquaculture Centers of Asia which links the Brackishwater Aquaculture Station at SEAFDEC in Tigbauan, Iloilo, with other centers in Thailand, India, and China.

Southeast Asian Fisheries Development Center (SEAFDEC)

SEAFDEC Aquaculture Department, established in 1974 in Iloilo, built extensive facilities for research and training in aquaculture. Facilities for specific research, such as the Fish Nutrition Laboratory, are still under construction. The Aquaculture Department has a core staff which provides training programs for participants from member countries or, by special arrangement, from countries outside the region. The Japanese government has contributed substantially with facilities, equipment, and funding. The Philippines contributes P30 million to the Aquaculture Department (22 percent of the GRP aquaculture budget) for infrastructure, maintenance, operations, and salaries of personnel. The Department cooperates with the UPV/BAC unit in Iloilo by providing facilities and training for graduate students in the aquaculture program. They also cooperate with FAO/Network of Aquaculture Centers in Asia by sustaining the Center's Brackishwater Aquaculture Station.

The Aquaculture Division maintains three stations, the Tigbauan hatchery/research complex and Leganes fishpond station (both in Iloilo Province) and the Binangonan freshwater station in Rizal Province. It also maintains several substations, such as a shrimp hatchery at Batan, Capiz Province, and a marine substation at Igang, Guimaras island, Iloilo Province. Since its establishment, the SEAFDEC has contributed substantially to the biology and controlled spawning of milkfish, to hatchery and mass production of penaeid shrimp post-larvae, and to culture techniques for various other species. It has financed a comprehensive socioeconomic survey of the aquaculture industry in the Philippines, and has conducted international and national training programs on such topics as hatchery, culture management, and aquacultural engineering. Various research and training projects have been partially supported by the International Development and Research Centre of Canada, the New Zealand government, and others.



Shrimp larval-rearing tanks at SEAFDEC.

The International Center for Living Aquatic Resources Management (ICLARM)

ICLARM, founded in 1975 and headquartered in Manila since 1977, is an autonomous, nongovernmental research institution with programs in aquaculture, fisheries, resource development and management, education, and training. Although international in scope, the Center has focused on Southeast Asia and the Pacific Basin. The Center's professional staff is small but productive. The performance and presence in the Philippines is highly esteemed. Filipino professionals use the Center staff and library both formally and informally. They publish five technical series and a newsletter on research findings and information specific or relative to the Philippines. ICLARM has cooperated with Philippine institutions on a number of aquaculture projects:

Cooperating Institution	Project Title
Freshwater Aquaculture Center, Central Luzon State University	Applied research in integrated animal-fish farming
	Assessment of integrated rice-fish farming technology for rural development in the Philippines
	Genetic improvement of tilapia broodstock in the Philippines
	Cooperative program of research and training in aquaculture and inland fisheries
Philippines Council for Agriculture Resources Research Development	Graduate study program in aquatic resources
Fishery Industry Development Council & Bureau of Agricultural Economics	Milkfish production economics

U.S. Agency for International Development (USAID)

Since 1971, USAID has supported three successive aquacultural development projects: the Inland Fisheries Project (IFP), the Aquaculture Production Project (APP), and the Freshwater Fisheries Development Project (FFDP). The goal of all three was to improve nutrition of the Filipino people by increasing fish production through aquaculture. The projects focused on three institutional capabilities considered essential to the aquacultural development in the Philippines—research, academic training, and extension. To accomplish these objectives, the IFP (FY 1971-74) concentrated on establishing two research/training centers; the Freshwater Aquaculture Center at Central Luzon State University and the Brackishwater Aquaculture Center in Iloilo Province. Key staff members from each center were sent to universities abroad for graduate training. Limited research activities were begun in facilities borrowed from GRP agencies and private individuals.

The APP (1975-79) focused on continued physical development of the centers, intensification and expansion of research effort, and establishment of academic and applied training programs. It also sought to institute an effective extension program within BFAR and to link extension with the research/training centers.

The FFDP (1979-present) addresses intensification and expansion of extension effort, development of a large-scale fish hatchery (up to 20 million seedlings per year), production and distribution facilities, and a market development and consumer education program.

Technical assistance for the projects was contracted by AID to Auburn University's International Center for Aquaculture in its Department of Fisheries and Allied Aquacultures (IFP and APP), and to Texas A&M University's Department of Fisheries and Wildlife Sciences (FFDP).

Several specific accomplishments resulted from the projects. Complete research/training facilities were established, thus allowing the creation of the BAC and FAC. Effective research programs were developed. Through the IFP and APP, 6 staff earned Ph.D. degrees, 10 earned M.S. degrees, and 11 others received graduate training abroad ranging from 4 to 24 months. Additional personnel have been or are being trained abroad under the FFDP. Both centers instituted academic programs leading to B.S. degrees in aquaculture. The UPCF established a graduate program (M.S. level) at the BAC, and an Extension Division was established in the BFAR. A comprehensive technology diffusion program was organized with extension staff of BFAR and research staff of the centers. The ongoing FFDP is attempting to strengthen and broaden these programs.

The projects were instrumental in assisting the GRP establish the institutional components fundamental to sustained development of aquaculture. These projects made possible other development assistance that might otherwise not have been available, but aquacultural development is in an immature stage, and continued progress is not guaranteed.

Other Bilateral Programs

The Philippine government has received assistance in fisheries and aquacultural projects directly or indirectly from other sources: the Japanese International Cooperation Agency, the Canadian International Development Agency, the Federal Republic of Germany, Israel, India, and China.

Impact of Donor Assistance on Training

The impact of out-of-country training is difficult to assess because information about earlier efforts is limited and we lack standards against which to compare the various training programs. From 1947 to 1949 a total of 124 persons was sent to the United States for a year of special training in fisheries under the U.S. Fish and Wildlife Service Philippines Fisheries Rehabilitation Program. When 67 of these individuals were traced, it was found that 24 spent the majority of their working life with the Bureau of Fisheries, 13 worked in fisheries education, 9 went into private business, 6 worked in banking, 4 worked in non-fisheries government agencies, 5 found work with international agencies, 4 died early in their careers, and 2 emigrated to the United States. Assuming that the individuals who were not identified did not enter fisheries-related work, about a third of those trained in fisheries spent most of their working lives in fisheries-related public employment in the Philippines, and another 10 percent worked in fisheries outside the government or the country. At least seven have worked for FAO. Several have risen to high positions, particularly in the Bureau of Fisheries.

Under the Inland Fisheries Project and Aquaculture Production Projects (1971-79) with USAID assistance, 18 Filipinos were trained in long-term (18-24 months) and 10 others in short-term (1-6 months) programs related to aquaculture. Of these trainees, all but three have returned and are employed in their respective agencies; one has emigrated to the United States, and one entered private consulting and business. Several of those still employed remain under obligation as they serve 3 years for each year of study leave. Those with advanced degrees are in great demand for consulting, which is usually permitted in recognition that their main employment provides low pay and slow advancement in academic rank or civil service grade. This same pattern is true for Filipinos trained under other projects, both in fisheries and other technical subjects.

Productivity of people trained outside the country is difficult to assess. Most of the better academic and administrative positions in fisheries have gone to individuals with advanced degrees from abroad. Except for the group that was trained abroad in the 1940's, this has been a relatively small number of individuals. For those receiving advanced academic training in aquaculture during the past decade, it is still too early to know the full impact of training on their careers and on the country. We can say that the substantial expansion of the academic and research programs in recent years has been due to the energies and abilities of those trained with project assistance. Now that domestic M.S. programs in aquaculture have become operational, there should be less need to seek foreign assistance for training to that level, but support for Ph.D. level training remains an important problem.

Although no reports are available on studies comparing different types of aquacultural training programs, analysis from this study shows that completion of an advanced academic degree has significantly affected professional careers. Generally, those completing higher degrees have expressed positive feelings about their educational experience and have felt that the personal sacrifice in achieving the training was worthwhile. Moreover, those foreign-trained individuals have retained an interest in the programs and faculty of their alma maters and in their contemporaries in graduate school.

Impact of Donor Assistance on Commodities

A substantial quantity of equipment and educational materials has been provided to the Philippines by donor assistance for aquacultural development. The high foreign exchange costs for many of these materials makes them unlikely to have been purchased without donor assistance. Although no extensive follow-up study has been done, it appears that basic tools and textbooks have been particularly valuable. Unfortunately, it has taken as much as a year for materials to reach the Philippines. Another drawback has been that many of the items were excess U.S. government property, with limited service life and high costs of repairs and replacement parts. Nevertheless, most commodities have been well maintained and used for the purpose for which they were obtained. Not surprisingly, vehicle deployment may be an exception since there have been several examples of jeeps or other service vehicles being commandeered by administrative officials or travel being restricted by budgetary constraints. Without continued donor assistance, it will be a burden on government agencies to replace wornout equipment.

Impact of Donor Assistance on Capital Development

Capital development expenses for most aquacultural projects have been a domestic counterpart contribution. With the exception of the facilities at SEAFDEC, most of the building costs have been modest, in keeping with the surrounding public structures. Project construction has often been more than a year behind, and not always of good design. Existing research facilities are more than adequate. In fact, the recent pledge by the Japanese government to build more facilities at CLSU may be overkill, particularly when basic needs such as the road and bridge to the Leganes aquacultural site and the UPV new facilities remain uncompleted.

CONSTRAINTS ON AND OPPORTUNITIES FOR CONTINUED AQUACULTURAL DEVELOPMENT

Aquaculture is a major factor in the Philippines, contributing 0.5 percent of the GNP, 5 percent of foods of animal origin, and approximately 200,000 jobs. Since the early 1970's the Philippines has been a pace setter for aquacultural development. Although levels of aquacultural technology are not high, they are successful under the prevailing conditions. In terms of the model used to describe aquacultural development, the Philippines has advanced from Stage 3 to Stage 5 in the past decade. Furthermore, the potential for continued growth is concluded to be among the highest of any country. Constraints on and opportunities for continued aquacultural development are summarized in the following description of technical, social, economic, institutional, environmental, political, and other factors.

Technical Factors

The Philippines has many environments where the climate, land, soil, and water are not constraints to aquacultural development. Typhoons, acid sulfate soils, and similar physical factors are constraints in some locations. Research on these and other problems reduces their effects on aquaculture development potential.

Expansion of brackishwater ponds is constrained by the limited number of choice sites and by regulations on mangrove swamp alteration. Expansion of pen and cage culture systems is restricted by the small number of lakes with nutrient-rich waters, overdevelopment in areas presently used, and lack of good quality feed. Expansion of freshwater ponds does not appear to be constrained at the moment, but increased land-use regulations could become a problem. Diseases and water quality related problems will become much more relevant as aquaculture is intensified.

Milkfish and tilapia are the primary cultured fishes and are well suited to conditions in the Philippines. Other native and introduced species of finfishes, molluscs, crustaceans, and seaweeds have varying potentials for culture. Some carps, particularly the grass carp, appear most promising. Prospects for culturing bullfrogs, channel catfish, eels, freshwater prawns, and other species are low given the competition from other species of known value and successful culture.

Limited availability and the cost of importation of organic and inorganic fertilizers and feedstuffs are also constraints to future aquacultural development. Intensive feeding levels (level 5 and above) are presently not feasible because of these restrictions.

Philippine producers have the knowledge and experience to practice intensive fertilization (level 3) and extensive feeding (level 4) in brackishwater and freshwater ponds. Intensification rather than extensification is recommended for brackishwater pond aquaculture, and both intensification and extensification for freshwater ponds. More information is needed on the technology, economics, and social factors involved in cage and pen cultures before we can recommend further development of these aquacultures.

Integrated agriculture-aquaculture systems, including rice and fish in paddies, pigs and/or chickens in pens adjacent to fish ponds, and various horticulture, animal husbandry, and aquacultural combinations, appear to have high potential throughout the Philippines.

Social Factors

Producer attitudes, knowledge, and skills about aquaculture are positive. They not only perceive the need for change, but are also actively pursuing new technology from internal and external sources, doing trial-and-error research, and sharing production information. In aquaculture, as in all industries, some entrepreneurs may have taken risks not easily justified by known production levels. Others have joined in highly speculative ventures for quick returns. In spite of some failures, opportunities appear positive to provide increased employment, income, and improved nutrition to the Philippine population through intensified and expanded aquacultural systems. Opportunities are most attractive for inland property holders such as rice farmers. The proposal by KKK for aquacultural development by community-based groups rather than by individual owners has interesting but as yet unpredictable possibilities.

Milkfish fry gathering is particularly valuable for employment of coastal residents in some areas of the Philippines. In 1977, 25,000 families depended on the collection of milkfish fry from the wild for all or part of their livelihood. The fry collecting industry was then valued at P57 million.

Pen and cage culture in lakes and mollusc and seaweed culture in estuarine and marine environments face a potential constraint from competition for the water resource and from conversion of public resources to private resources. Land reform for fishpond and other aquacultural operations requires serious consideration.

Economic Factors

The elasticity of demand for presently produced aquacultural foods appears to be high—0.22 and higher. This will likely improve as capture fishery production stabilizes or declines. Domestic markets are expected to absorb all non-luxury aquacultural production of finfish (milkfish and tilapia) for the foreseeable future with or without competition from capture fisheries and agriculture. Domestic markets for crustaceans, molluscs, and seaweeds may be limited. The major economic constraints for producers are the high capitalization requirements and the inaccessibility and high cost of credit. Low availability and poor access to nutrient inputs are a further constraint.

Participation by poor landless people in commercial aquaculture as owners or primary beneficiaries seems unlikely because they lack the capital, credit, and land area required for economic viability. They also have questionable managerial ability and low risk tolerance. Rice farmers appear to have opportunities in aquaculture by converting rice paddies to rice-fish paddies or fishponds. Such facilities could be used for subsistence or limited commercial production with potential for expansion into commercial operations.

Infrastructure, especially the availability of ice and transportation, is a constraint to producers outside the Manila-Central Luzon area. The costs of inputs and marketing rise with increasing distance from Manila. The attitudes of borrowers toward bank loans must also be considered since some disregard repayment obligations and others may use loans for other purposes. This behavior has compounded credit problems. Hidden costs to a thriving "pay-off" system are alleged to be significant.

Institutional Factors

The lack of adequate numbers of well-trained scientists for research, teaching, and extension is the most serious institutional constraint for development of the aquaculture industry. An internal Ph.D.-level graduate program is desperately needed to produce quality manpower at all levels and to assure survival of scientific research and graduate level academic programs. The Ph.D. program, accompanied by more effective means of keeping highly trained manpower productively employed in the university system, is essential.

Research facilities are more than adequate for the next decade, but budgets and qualified research personnel are presently inadequate to maintain and operate them. Already strained budgets are not likely to increase commensurately with the new facilities presently under construction.

Research programs appear fragmented, without clear direction. Research addresses easy solutions, avoiding the tough problems. Evidence is strong that time and energies of senior research personnel are spent in the following order: (1) extraneous consultancies, (2) administrative responsibilities, (3) teaching, and finally, (4) research. Social and economic research must be coordinated with the technological research.

Academic facilities and programs are marginally adequate for M.S.-level training. However, accreditation of B.S. and especially M.S. programs is in jeopardy because of the high probability of losing the already limited numbers of qualified professors.

Extension capability appears to be below the levels of research and academia. It suffers from low morale, incomplete programs, and inadequate support. Possible remedial alternatives include:

1. Totally decentralizing extension responsibilities to the regional offices.

2. Reorganizing and reprogramming extension functions and upgrading job qualifications.

3. Transferring all extension responsibilities for aquaculture from BFAR to the Bureau of Agricultural Extension or NFAC.

4. Encouraging the private sector to provide its own extension needs on a GRP-reimbursable basis, perhaps through the Philippine Federation of Fishpond Producers.

There is no speculation on the long-range impact of the high proportion of women in current programs. Women comprise 60 to 70 percent of the trained manpower and the majority of current M.S. students.

Administratively, the GRP has generally done an admirable job in supporting aquacultural development. All needed organizations are in place with broad and reasonably thorough programs. However, goals, policies, and programs are organized horizontally rather than vertically. This tends to promote a strong bureaucracy rather than strong development services. There is a tendency for budgets to barely meet salary requirements with little left for operations support. Budget allocations must reflect the needs associated with recent construction, and perhaps should be balanced to give extension services more than they are currently allocated. Proliferation of agencies and institutions has grossly diluted resources, created duplication and confusion, and hampered effectiveness of services.

Regulations and bureaucratic procedures relative to aquaculture appear reasonable, but enforcement is generally weak and paper work for permits and loans is extremely slow. Accountability by institutions and personnel at all levels within institutions, especially BFAR, is needed. Typical of most governments, authorities are often unable to deal with weak performance by agencies, divisions, offices, and individuals.

The operation of some BFAR stations and hatcheries is suspect. Part of the P8 million research budget of BFAR could probably be used more productively and efficiently by universities and other institutions better equipped and staffed for the work. BFAR hatcheries are not productive and some fry distribution/stocking programs are of questionable value.

The Philippine Federation of Fishpond Producers, with 12 regional and 37 provincial chapters and 30,000 members, recognizes the need for technology development and transfer, and is willing to participate in that effort. Funding and pledging professional chairs at UPV and seminars for members, including small-scale farmers and operators, are examples of their involvement. It seems obvious that the opportunity for all Philippine aquaculturists to help themselves and for GRP to help all aquaculturists help themselves is greater through collaborative efforts rather than through independent action.

Funding of research and development of aquaculture in both private and public sectors should be both internal and external. Inputs such as manpower, technology, and statistics should be drawn from internal, rather than external sources.

Environmental Factors

Actions of the GRP to regulate fishponds and limit their expansion into mangrove areas are positive steps in protecting an ecologically and economically important resource. Preservation of mangrove areas could be the most beneficial service the GRP can provide to municipal fishermen at this time. Allowing poorly developed or unproductive fishponds to revert to mangrove forest may be the best use of those areas.

Development of freshwater inland ponds would probably not impact negatively on the environment, but the impact of pens and cages on lake environments is not well understood. The potential adverse effects of cultured species and eutrophication from feed may be negative aspects of pen and cage culture.

In spite of strong encouragement for the GRP to establish commercial hatcheries for milkfish fry, that action is not recommended since the technology is not yet available and fry are not scarce enough to be a constraint to the continued growth of milkfish aquaculture. A major consideration is that 25,000 coastal families depend on fry collection for part or all of their livelihoods—an industry valued at P57 million in 1977.

All species introduced for aquacultural purposes have had at least some negative impact on the environment. While some tilapia have been economically beneficial and, therefore, may be judged worth the environmental cost, others, such as Zilli's tilapia and Thai catfish (Thai hito), are likely to be judged not worth the cost. It is suggested that the GRP tighten its control on imports and distribution of exotic species. The GRP should also control potentially toxic substances such as endrin and some other pesticides still in use in fishponds. Domestic pollution in mollusc production areas enhances production but limits markets because of the high risk of disease.

Political Factors

GRP stability, commitment to aquacultural development, and successful solicitation of donor assistance grants and loans for aquacultural projects have all been positive. Peace and order problems in some parts of the Philippines remain a constraint to aquacultural development.

Aquaculture as an Employment Alternative for Small-Scale Fishermen

Small-scale fishermen and their families, estimated at almost 2 million people or 5 percent of the population, are among the poorest in the Philippine economy. The resources upon which these artisanal fishermen depend are fished at or above their maximum sustainable yield. Faced with these prospects, some people have suggested that aquaculture be developed as an alternative source of livelihood and employment for some of these small-scale fishermen. They reason that the transition from gathering fish to culturing the same types of organisms would appear to be a natural progression and a logical response to economic pressures.

The problems and solutions for small-scale fishermen have been the topic of several international meetings: the 1975 gathering in Costa Rica (*15*), the 1980 Indo-Pacific Fishery Commission Symposium in Japan (*22*), and the November 1981 workshop-seminar in Manila sponsored by the FAO/UNDP South China Sea Fisheries Development and Coordinating Programme (*18*). Several papers discuss potentials and socio-economic considerations for aquaculture in dealing with these small-scale fishermen. (See bibliography, page 31.) The characteristics of small-scale fisheries in the Philippines have already been reviewed by Smith et al. (*43*). The following sections will not redescribe existing information, but rather interpret their findings relative to opportunities for small-scale fishermen in aquaculture.

Potential Small-Scale Aquacultures

Brackishwater fish culture in coastal ponds is by far the best established aquaculture in the Philippines and is practiced in areas near artisanal fishing grounds. The yields from existing ponds are generally below their potential. Intensification makes sense and would increase labor demands. Some, if not most, of this labor would be people otherwise employed in subsistence fishing. It is difficult to estimate how much employment might result from intensification, but assuming an additional man for every 10 hectares and a total of 50,000 hectares, intensified management would mean new work for 5,000 people.

It is also concluded that expansion of brackishwater pond development into new areas is not desirable because of the need to preserve the apparently limited coastal mangrove forests. These areas are already heavily exploited by coastal residents and have important ecological functions that should not be lost. On the contrary, consideration should be given to allowing low-yielding brackishwater ponds to revert to mangrove.

One approach to bringing fishermen into aquaculture was the creation of "fishery estates" where a large new area is developed into ponds and subdivided into small family-sized units with individual unit production supported and coordinated by a central association. Such schemes have been attempted in Indonesia and Taiwan with little success in achieving the social objectives. Similar proposals were made for the Philippines, and such developments were introduced in Zamboanga and Mindoro. Opinions are mixed as to the chance of economic or social success. Some of the authors of this report believe the potential is sufficiently promising to be tested. Others are less optimistic, in part because of conclusions at a large workshop convened in Los Banos about 1975 on the feasibility of fishery estates. The general conclusion from this workshop was that the development costs were too high and the rate of return too low. There also was a high cost per beneficiary (a multimillion peso case example of 500 hectares would directly benefit only about 100 families at a cost in excess of $20,000 per family). If the fishery estate mode is tested for social reasons, it should be limited initially to a pilot scale (e.g. 50 hectares).

The idea of seafarming for marine algae or molluscs has also been proposed for coastal fishermen. The technology for such activities is available but the markets appear to be limited and sensitive to oversupply. Favorable sites for either of these activities are scattered and moderately high capital and risk are involved. Smith and Pestano-Smith (*42*) reviewed the recent history of seaweed farming in the Philippines, and SEAFDEC (*44*) and FAO (*18*) have recently evaluated mollusc culture. Oyster and mussel culture have reasonable potential but need facilities for sanitary control if market expansion is considered.

The booming pen and cage fish culture activities in Laguna de Bay have led to an ADB-financed Laguna Lake Development Authority project to assist lake fishermen into milkfish or tilapia cage or pen culture in a reserved area of the lake. Reports on the success of fish culture in Laguna de Bay enclosures are mixed. Such pen/cage cultures would only be practical in extremely fertile waters, such as some parts of Laguna de Bay. Clear rivers or lakes and open sea areas would not sustain good fish growth in densely stocked enclosures. The use of artificial feeds, even if available, appears to be prohibitively expensive for use in fish culture at this time. Those venturing into pen/cage cultures should recognize that such cultures are high-risk and capital intensive if practiced on a large-scale or intensively. The best sites in Laguna de Bay may already be taken.

Social Issues

Bakar and Arshad (*5*) and Pollnac (*37*) suggest that many artisanal fishermen would resist shifting to aquaculture because it was not suited to their temperament or traditions. This would be true of some Filipino fishermen, but results of Smith et al. (*43*) indicate that many would gladly take up farming if they could get access to land or a paying job. Some fishpond caretakers and laborers apparently turn to the capture fishery to augment their income from aquaculture. Many Filipinos fish simply because they have little other employment opportunity. The socioeconomic pressures have forced them to the water's edge. This also means they have little opportunity to move inland to take up freshwater aquaculture. Demand for space even at the water's edge is great. Where significant numbers of subsistence fishermen are given other employment, they are quickly replaced by new people. This means the prospects for taking pressure off the capture fishery resources are not good.

Low income people are also handicapped in new business undertakings. By background they have little education, poor communication skills, and little managerial or financial experience. Therefore, subsistence fishermen brought into aquaculture would be vulnerable to manipulation and exploitation by outside forces and at a competitive disadvantage with other operators.

New issues arise when open access public resources become subject to private monopolization, as would be the case with the development of many types of aquaculture. The encroachment of private fishpens into public fishing areas of Laguna de Bay is a good example. Adding ponds in communal coastal mangrove forests, locating cages in public lakes and rivers, setting mollusc attachment structures in bays and rich estuaries, and fixing nets for seaweed farming are more examples of potential conflicts. Who gets the best locations, how much, at what cost, for how long, how to regulate competition, and similar questions must be resolved in advance. To achieve broad social benefits, regulations must be made and enforced to divide public resources into small (not necessarily the most efficient) units.

Team members expressed mixed opinions regarding the constraints and opportunities for aquaculture as an employment alternative for small-scale fishermen, obviously presenting more constraints than opportunities. All agree on the need to help the large number of low-income fishermen, but do not foresee that development of aquaculture will provide them an alternative livelihood or relieve pressure on the municipal fishery resource. Growth of aquaculture in the coastal areas will apparently be limited by the number of sites for new ponds. Intensified production in existing ponds would be expected to slightly increase labor demand. The need to preserve mangrove swamps, economic factors, market demand, and social ownership issues will likely limit development of coastal aquaculture for small-scale operators. Inland aquaculture opportunities will likely be taken by those already on the land rather than by new arrivals. Although results of the trial fishpond estates in Zamboanga and Mindoro are not available, it is noted that costs and benefits for developing coastal aquaculture estates are not likely to compare favorably with other development investment alternatives. Last of all, the fishery will not be saved even by providing other employment. The number of potential fishermen is just too great. Research is recommended rather than development projects in pursuance of opportunities in aquaculture for municipal fishermen. If development projects must be implemented, a multi-disciplinary approach that would address the social, economic, and technical elements is strongly recommended.

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APPENDIX A

Fishery Regions of the Philippines

The regions in the Philippines were numbered from I-XI until 1979; after that time, X-XII. In this report, especially tables 9 and 10, the following assignment of provinces to regions is used.

Region I: Ilocos Norte, Ilocos Sur, La Union, Pangasinan
Region II: Cagayan, Isabela, Nueva Viscaya
Region III: Bataan, Bulacan, Pampanga, Tarlac, Zambales, Aurora Sub. Prov., Nueva Ecija
Region IV: Batangas, Cavite, Laguna, Marinduque, Rizal, Mindoro Occ., Mindoro Or., Palawan, Quezon, Romblon, Metro Manila
Region V: Albay, Camarines N., Camarines Sur, Catanduanes, Masbate, Sorsogon
Region VI: Aklan, Antique, Capiz, Iloilo, Negros Occ.
Region VII: Bohol, Cebu, Negros Or.
Region VIII: E. Samar, Leyte, No. Samar, S. Leyte, W. Samar
Region IX: Sulu, Zamboanga del Norte, Zamboanga del Sur
Region X: Agusan del Norte, Agusan del Sur, Bukidnon, Lanao del Norte, Lanao del Sur, Misamis Occ., Misamis Or., Surigao del Norte, Surigao del Sur
Region XI: Maguindano , S. Cotabato, Davao del Norte, Davao del Sur, Davao Or.