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DEVELOPMENT OF AQUACULTURE

IN THE

PHILIPPINES

by

H. R. Schmittou, J. H. Grover, S. Peterson, A. R. Librero
H. R. Rabanal, A. A. Portugal, and M. Adriano

Edited by Susan Peterson
Woods Hole Oceanographic Institution
Woods Hole, MA 02543

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Study team:

Dr. H.R. Schmittou Aquaculture/Team leader	International Center for Aquaculture Auburn University, Alabama
Dr. Marietta Adriano Programs/Administration	National Economic Development Authority Government of the Republic of the Philippines
Dr. John H. Grover Institutional Development	International Center for Aquaculture Auburn University, Alabama
Dr. Aida R. Librero Fisheries Economics	Philippine Council for Agricultural Research and Resource Development
Dr. Susan Peterson Anthropology	Woods Hole Oceanographic Institution Woods Hole, Massachusetts
Mr. Aristeo A. Portugal Fishery Program Development	National Economic Development Authority Government of the Republic of the Philippines
Dr. Herminio R. Rabanal Aquacultural Development	United Nations Development Program/ Food and Agricultural Organization South China Sea Fisheries Development and Coordinating Program

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FOREWORD

The research reported here was proposed by Auburn University to the U.S. Agency for International Development in an effort to understand and improve the business of international development. Auburn University, through its International Center for Aquaculture (ICA), has been involved in aquacultural development internationally since 1967. ICA personnel have served in the aggregate more than 60 years on long-term and 20 years on short-term assignments in 76 different countries. The ICA is continuously in search of ways to strengthen its capabilities to assist donor and host agencies in all phases of the development process.

Agricultural development is the basis for socio-economic development for most, if not all, countries. Aquaculture, a form of agriculture, shares with it some but not all of the basic development principles and concepts. An improved understanding of aquacultural development processes will enable ICA and other institutions to develop more practical, teachable and testable concepts, procedures and guidelines for development. These include project identification, feasibility, design, implementation and evaluation.

This study of aquacultural development in the Philippines was conducted by a multidisciplinary team from February 15 to March 25, 1982. The team included an anthropologist, two agricultural economists, a fishery economic development specialist and three aquaculturists with specializations in aquacultural technology, overall socio-economic development and aquacultural institutional development. The study team included: Dr. H.R. Schmittou, Aquaculturist and Team Leader from the ICA at Auburn University; Dr. Marietta Adriano, Programs and Administration, National Economic Development Authority, Government of the Republic of the Philippines (GRP); Dr. John H. Grover, Aquaculturist and specialist on Institutional Development from the ICA, Auburn University; Dr. Aida R. Librero, Fisheries Economist from the Philippine Council for Agriculture and Resources Research Development in Los Banos; Dr. Susan Peterson, an Anthropologist and specialist in Fisheries Management from Woods Hole Oceanographic Institution in Massachusetts; Mr. Aristeo A. Portugal, specialist in Fishery Program Development from the National Economic Development Authority, GRP; and Dr. Herminio R. Rabanal, specialist in Aquacultural Development, associated with the United Nations Food and Agriculture Organization, South China Sea Fisheries Development and Coordinating Program based in Manila. The study was a cooperative effort between the ICA, U.S. Agency for International Development in Washington and in the Philippines, and the National Economic Development Authority/GRP.

The study was conducted through review and interpretation of existing information without attempting to gather primary data. Obviously, a large number of individuals and agencies in both public and private sectors contributed directly and indirectly to the information base, and their assistance was greatly appreciated.

INTRODUCTION

Most countries have participated in international development, either as donors or recipients, through bilateral and/or multilateral projects. In the U.S., international development assistance has been supported for almost four decades, yet the business of international development 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, then it is likely that information was not adequate to do realistic planning at the time the project was conceived. 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 complete relative to the social, economical, institutional, governmental, environmental and technological factors involved. But this report is not an example of the ideal impact assessment. It was a compromise between what we would like to have been able to do in all development projects and what we knew we would be able to do, given constraints on such essentials as data collection and

recording. What we have done here is to try to describe the system and its evolution, and then to see if existing data could be used to indicate any cause/effect relationships between assistance in development and economic/social well-being in the country.

The objectives of the study were:

1. to determine the impact of aquacultural development, in general, and the contribution of cooperative (private, public and donor sectors) projects, specifically, on consumers, producers, GRP service institutions, the environment, and overall socio-economic development of the country;
2. to measure contributions of donor assisted aquacultural projects to country development goals;
3. to determine as accurately as possible the return in social, economic and other benefits to project costs;
4. to identify existing constraints and potential constraints (e.g., economic and environmental) and opportunities (e.g., for food production with aquaculture alone or as an integrated system, and employment potential for underemployed inshore fishermen of the rural workforce) for future, long-range aquacultural development, and recommend ways and means constraints may be minimized and opportunities maximized.
5. to apply and evaluate a six-stage aquacultural developmental model using the Philippine aquacultural development history.

This report is a description of the past, present and expected future trends in development of aquaculture in the Philippines, and an assessment of roles that private, public and donor sectors played or might play in this process.

The Philippines was chosen for this case study because of its aquacultures in brackishwater, freshwater, and marine environments using ponds, cages, pens and racks. The history of aquaculture in the Philippines spans a period of some 500 years, and fish produced through aquaculture are significant in the Filipino diet. Fish from aquaculture systems ranged from 8% to 12% of all fish produced from 1951 to present (Bureau of Fisheries and Aquatic Resources Statistics Year Books), and milkfish production is 90% of all aquaculture production. Milkfish production has a range of benefits throughout the country which occur from fry gathering and distribution, nursery pond operation, rearing pond production and marketing, activities which generated slightly less than 1/2 of 1% of the GNP (Fishery Industry Development Council 1981a). The Philippines has increased production from aquaculture over the past decade, has great potential for continued growth, and a long and varied experience with donor-assisted projects in aquaculture. In addition, the Philippines was thought to be a good example in the developing world of the partnership in aquacultural development between 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 developing country. The Philippines has had a relatively stable social-political system since World War II and many people who played active roles in aquacultural development activities are still alive. 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 here 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, to permit control over the production and harvest, and to take advantage of areas marginally productive for other crops. The amount of actual control an aquaculturist has on production in an environment is relative; for the most part the aquaculturist only manipulates certain components of the environment to enhance natural production. A knowledge of the amount of control exercised over the culture environment can be 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, nutrient inputs available, species feasible for culture, and the abilities of producers to balance all the factors in a profitable and productive package. The physical environment is an independent variable in the development equation; it is essentially fixed, though subject to minor modifications. The physical environment includes climatic conditions such as temperature cycles, rainfall patterns and typhoon incidences; land elevation and topography; soil characteristics, particularly water holding capacity and probability for acid conditions; water availability, manageability and quality; geographical barriers to supplies and/or markets. If these conditions are not suitable for aquacultural development, there is little that can be done to change them. The Philippines has many sites in a variety of different environments that are well-suited for aquacultural development. These sites range from freshwater upland ponds

to rice paddies and eutrophic lakes, to coastal brackishwater mangrove swamps and estuaries, to saline bays and shallow seas.

Analyzing the amount of control allows for aquaculture to be broken down 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 the controlled environment to enhance, supplement or replace the natural food base. We would group aquaculture systems into seven general technological levels. The levels overlap for any given aquaculture, but balance in the levels of modification, control and nutrient inputs is far more common than not. The criteria for determining technology levels are relative, but the nutrient inputs are less relative, therefore, more descriptive and hence the descriptive title for each level.

Level 1. Extensive - only slight modification of the environment; little or incomplete control over such factors as water flow and levels, number and kinds 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 harvest; 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; moderate and generally complete control over water and species raised and harvest; quality and quantity of fertilizer are available to achieve near maximum yield.

Level 4. Extensive feeding - modification and control as in 3; nutrient inputs as in 3 or with low quality or quantity feed, usually feedstuff or agricultural by-product to supplement natural foods.

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 possible without aeration.

Level 6. Hyperintensive feeding - 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, recreated environment such as tanks and aquaria; control is relatively complete over temperature, pollution, DO - CO_2 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 systems and practices in the Philippines are not as diverse as might be expected of one of the world's leading aquaculture producers. Milkfish culture in brackishwater ponds accounts for approximately 90% of total production. Milkfish in lake pens, tilapia (combined with other kinds of fish) in brackishwater and freshwater ponds, pens, floating cages, and rice paddies; penaeid shrimp in brackishwater ponds; oysters and mussels on stakes in shallow coastal waters; and *Eucheuma* seaweed on submerged netting and racks account for the remainder. 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 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 for culturing milkfish in the Philippines.

Milkfish pond aquaculture was introduced in to the Philippines, probably on Mactan Island in the Visayas, during the 15th Century from Indonesia or Malaysia. From its introduction until well into the 20th Century, perhaps about 1930, it was practiced only at a level 1 technology (Table 1). Yields

Table 1

Explanation of different levels of aquaculture technology using milkfish culture in brackishwater ponds in the Philippines as the example

Level/ Description	Environment		
	Modification	Management control	Nutrient inputs
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; no. and 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 lablab 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 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 liking 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 with pumps more likely.	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

probably varied between 50 and 250 kg/ha with an average of not more than 100 kg/ha. Level 2 technology probably became significant around 1930; level 3 about 1946; and some level 4 by 1960. However, until now levels 1 and 2 were the predominant technology levels applied, 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 control for level 5 and some level 6 technologies; however, feeds and feeding technology are lacking, especially at level 6. Whether or not feeds will be developed and used to advance milkfish culture to levels 5, 6 or 7 will be influenced by economics rather than of technology. Feeds for fish need to be higher in protein than those for poultry and livestock, but local by-products and feedstuffs relatively high in protein are scarce, forcing feed producers to import fishmeal, soybean meal and similar protein-rich materials to meet present poultry and hog feed requirements.

The trend towards feeding is balanced with trends toward more specialized ponds of specific design and construction 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. And not only are producers using more fertilizer, but also they are using a higher percentage of inorganic forms. Although some producers have shifted from milkfish to penaeid shrimp culture, these trends and pressures toward greater intensification in some areas appear 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 peace and order problems. Intensification may be 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 speices 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 modify the original environment (level 1) of this large lake appreciably. The culturists are not able to exert much control over the environment (level 1); they may 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 used but the natural and domestic waste nutrient loading into the lake are equivalent to intensive fertilization (level 3). Rice bran is frequently used as a feed to "fatten" the fish before harvest (level 4). The net effect of technology applied is equivalent to only slightly more than level 1, but because of the heavy nutrient loading, the net effect of benefits returned is equivalent to level 3 technology. Benefits would of course be lower in environments with fewer nutrients.

Tilapia culture in cages

Nile tilapia are being cultured in cages in Laguna de Bay and some other lakes. This practice, begun in the late 1970s in Laguna de Bay, is rapidly

expanding. The cages are floating bamboo pens with monofilament net enclosed bottoms and sides. 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 other less fertile lakes have reduced fish production potential.

Tilapia culture in freshwater ponds

Tilapia are beginning to be cultured in relatively small, inland freshwater ponds for subsistence and small-scale commerical 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 being 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 insecticides on rice.

Tilapia are becoming more popular with producers and consumers; what was once the "poor man's milkfish" because their market value was so low 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 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 until now an incidental or secondary culture to milkfish. Shrimp are 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 post-larval survival. 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 affect 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 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 for that purpose is disputable. The total area of fishponds in the country is difficult to determine from the statistics available from the Bureau of Fisheries and Aquatic Resources (BFAR). Their Statistics Yearbooks reported a constant area of 176,030 ha for 1973 to 1975, and a slight increase to 176,230 ha was reported annually from 1976 to 1980. But experienced researchers find it difficult to agree with such statistics. Librero (1976) says that for the entire country the average non-operational area in a fish farm was 2.66 ha or 17% of total farm area; this would leave 146,000 ha of pond area if the approximately 176,000 ha total were correct. Samson et al. (1976) claim that aquaculture production uses 120,000 ha of fresh and brackishwaters with average production of 500 to 600 kg/ha. Smith (1981) tried to improve the estimate of hectares in use, and concluded that there could be as much as 142,097 ha of fishponds. Chong et al. (1982) agree that 176,000 ha may be an overestimate and suggest it results from inclusion of government lands for which applications to alter the land 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 ha — are coastal mangrove forest. Further conversion of mangrove, however, is limited by government policies which define other long-term uses of mangrove 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 makes it rank as one of the four top countries in total fishpond area. However, development of ponds has had some deleterious effects on the country. These result from modification of the natural habitat when ponds were created, the effects of introduced 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. Mangrove forests in the Philippines now consist of from 220,243 ha (Natural Resources Management Center - NRMC, 1979) to 249,138 ha (Bureau of Forest and Development - BFD, 1977). 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 great importance of mangrove forests was emphasized by 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 by the international workshop on mangrove and estuarine area development (Manila, November 14-19, 1977). The benefits of mangrove forests to nature and society are many, including (in no specific order): providing means for soil deposition; preventing rain, flood, wave and wind erosion; providing rookeries for birds; 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, dyebark; 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 (1980) cites numerous research findings showing a postive correlation between shrimp landings and the extent of mangrove and intertidal vegetation. Turner (1977) analyzed shrimp landings averaged for several years for 27 locations around the world and found the data supports 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 (1974) 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 (1918) 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 (1979) emphasized the importance of the mangrove zone for direct use by poor rural people: "...the bulk of the population that use 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 an entirely different or 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 quandry. Their task of chosing among conflicting or incompatible options is complicated by lack of understanding of socio-economic and environmental issues involved. It is further complicated by traditional emphasis on economic evaluations 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. This is especially so if fishponds are ineffectively or not intensively managed. It is conceivable that a hectare of mangrove area in its natural state would contribute as much as 100 kg 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 from milkfish produced in a hectare of pond. However, no measures have been made in the

Philippines on a) the effect of pond development on the natural fishery in and adjacent to the mangrove area, or b) on the shrimp fishery in and outside those areas. Turner (1977) calculated the loss of shrimp and fish in trawling operations in Indonesia from converting mangrove areas to fishponds to be 767 kg/year for each hectare converted, and 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% per year in the first 10 years, but only 0.8% per year during the last 8 years. In 1978 the Ministry of Natural Resources (MNR) reported 2795 applications for fishponds covering 52,393 ha or 21% to 24% of the remaining mangrove areas in the country (Table 3). However, BFAR reports only 2130 ha 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 from several months to years. The difficulties in building new ponds probably accounts for some of

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	0.8
	Total	87,550	99	3.5

Table 3
Existing mangrove area in the Philippines[1]

Mangrove Status	Hectares	Mangrove Area (%)	Total area (%)	Source
Closed canopy	146,140	66.4	36.9	
Open canopy[2]	74,103	33.6	18.7	NRMC
Subtotal	220,243	100.0	55.5	
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	BFD
Subtotal	249,138	100.0	58.6	
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. 1979 by Gomez 1980).

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 left incompletely 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 mangove 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). Open canopy area consisting of 74,103 ha (NRMC) composes 34% of the remaining mangroves, and Bina et al. 1979 (Gomez 1980) consider open canopy to represent "the preliminary stage of fishpond/saltbed conversion." However, BFD classifies only 22,904 ha, or less than 10% of the BFD estimated total, to be disposable and available to fishpond development.

The following is a summary of the major regulations concerning fishpond development and practices in mangrove areas:

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 with renewable for an additional 25 years; leasees are required to submit semi-annual reports under oath of development, operations and production.

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

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

6. PD 905 holders of leases are required to plant trees extending to at least 20 m 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.

The GRP has taken steps to protect the mangrove zones from destruction - steps that are conceivably 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 - a management program which depends on definite goals and clearly stated policies formulated within the social, ecological, political, institutional and economic framework. Lindblom 1968 (Baines 1974) is credited with declaring 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 that produce low yields.

MacNae (1974) 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 the 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

6) the loss of offshore fisheries due to the removal of the mangrove forests."

MacNae's assessment and balance considerations should be based on social and environmental factors as well as on economics.

Freshwater aquaculture

The Philippines also has a potential for fish production in freshwater; a recent estimate is 500,000 ha of freshwater areas available for fisheries development (Asian Institute for Aquaculture 1978). Some of this potential is beginning to be realized in Laguna de Bay where milkfish are being raised in fish 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 wildlife and human users, ponding may result in higher water levels in nearby wells during dry seasons when water could be limited or unavailable from other sources.

Pens and cages in lakes

The impact of aquacultures in 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 do very little to alter

the environment. The technology applied is primarily level 1; the level 2 technology applied contributes little to eutrophication. In fact, eutrophication is probably decreased by removal of nutrients from the lake by the tons of fish harvested from the culture facilities. The fishes used in this culture are primarily milkfish and tilapia which are very 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. Tilapias freely reproduce inside and outside the facilities, but milkfish do not reproduce. Thus, where tilapia exist, the pond is permanently altered; where milkfish exist without tilapia, alterations may be only termporary, depending on the numbers, gross weight and longeivity of milkfish in the environment.

Introductions of exotic species

Except for the negative environmental impact of mangrove destruction, the greatest destruction to Philippine aquatic environments is 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 number of species introduced nor on their distribution within the country.. Most known introduced species are well-established. The positive and negative effects of the exotic species are also not known. Regulations to prevent indiscriminate introductions of exotic species are thought to be ineffective, and we assume introductions of new species and new introductions of previously introduced species continue.

Pesticides in fishponds

Pesticides are used in brackishwater ponds as 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 it remains toxic for several years. Endrin and some other persistent pesticides have been banned from use in fishponds although they continue to be used illegally. In recent years both the private and public sectors have become more cautious about pesticide use and more aware of negative effects on the environment and the food chain.

Other environmental considerations

Finfish and crustacean aquacultures have not been implicated in incidences of communicable diseases. Current nutrient additions are too low in quality or quantity to be major influences on the environment. There are other possible negative impacts of aquaculture activities on the environment; we do not know the impact of removing wild milkfish fry or fry of other species on the natural stocks of those species, nor do we know 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 of social organization of milkfish production exists with the exception of Smith's (1981) description of milkfish fry gatherers, Librero (1976, 1979b), Chong et al. (1982), and Yengoyan's (1976) research based upon interviews with fishpond operators from Capiz. Yengoyan described pond operators as members of one of three groups or types. The large producers -- those with fishponds greater than 15 ha -- 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% of the producers but responsible for up to 75% of the production. He described them as actively manipulating the environment.

The second group of producers — about 15% of fishpond owners — were described as men with more limited knowledge of the ecosystem who farmed up to 15 ha. Instead of reinvesting in fishpond development, most of these pond operators invested 50% or more of 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 does not indicate whether they: a) inherited their ponds and aquacultural plots, b) started as farmers and were attracted to pond operations because of high probabilities for profit, or c) started with fish

ponds and added agricultural land because the fishponds demanded more capital than they had access to for optimal development, or d) 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 enthnicity is an important factor in product distribution; however, we saw no other references to ethnic difference 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 make up 75% of the individuals - were 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 farm lands.

Capiz area fishpond operators may be similar to pond owners throughout the country, although Librero (1976) reports greater non-pond economic activity for the pond operators with more than 15 ha than Yengoyan did. For example, her data show 66% of ponds of greater than 50 ha 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, we are willing to assume 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% of female pond owners and 1% female caretakers reported in Librero et al. (1977), we have no information; we do not know if they inherited or purchased their ponds, if they are entrepreneurs, if they are part of a trend toward greater involvement of women in fishpond businesses, nor do we know 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. (1977) estimated that for capture fishing, 25% 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 caretakers, 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 (Nicolas and Librero 1979).

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 (Librero et al. 1977). In 1974, the monthly caretaker salary was equivalent to P7/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 (Librero 1976). This high percentage of college-educated fish farmers allows us to assume 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 in capital and 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% reaching college.

Among all pond owners interviewed by Librero (1976), 62% were operated by the owner, although none of them considered the ponds as full-time work. Owners reported that 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%) of the owner-operators fished during their working time away from the pond, as did 28% of 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 (Laopao and Latorre 1979).

Fishpond owners averaged 50 years of age with caretakers slightly younger at 46 years. The small-scale fishermen in Leyte (Laopao and Latorre 1979) were on average much younger than fishpond owners and caretakers (age 25-44 yrs) and less well educated, with fewer than 40% of them having education beyond primary grades. 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 any 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% of all agricultural workers and about 5% of the total work force. Approximately 18% of fishery workers are wage/salary earners, 66% are self-employed, 2% are employers, and 14% are unpaid family workers (World Bank 1979). A majority of 67% are engaged in municipal fisheries, 5% is commercial fisheries, 22% in aquaculture and other inland fisheries, and 6% in fish processing.

A government survey concluded that among graduates of agriculture, forestry, and fisheries programs the largest porportion 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% were unemployed for three years or more. Statistics on investment and employment estimates have been based on constant multipliers

(e.g. P10,000/ha investment and one person/ha 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 aggregate fisheries, more particularly aquaculture, from the marine and freshwater fishing industry.

Family

In the study of Capiz fish farmers, Yengoyan (1976) 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 sufficient 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-houshold 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. (1982) 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 the 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 (Chong et al. 1982). Among the 1,175 sample respondants in the Librero (1976) aquaculture survey, only 134 or 11% were members of aquaculture organizations. These associations make representations to the government and serve as a source of information for their members. Benefits of membership vary depending upon 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 is practiced in only a few associations.

Value of fishponds

Brackishwater fishponds are considered valuable real estate, and although some of their value results from good management, Herre and Mendoza (1929) point out that the ponds themselves have different values depending upon 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 1950s to 1970 values rose by 4.2% per year, and by more than 10% per year in the 1970s. General estimates of current fishpond values are approximately P50,000 to 80,000/ha.

Fishpond operating costs

Librero (1979a) estimates that to operate the average pond (13.5 ha) for a year, an operator would need a minimum of P19,390 or P1,437/ha to pay for stocking (31% of costs and discussed in detail below), labor (17%), fertilizer (15%), 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. (1977) estimated an average of 16.8 man days/ha for all operations involved with one crop. Dike, screen and gate repair require 50% of the labor, but this is done over a short time. Stocking uses very little labor — estimated at one hour/ha.

These costs can be contrasted with operating costs for small boat fishermen. Laopao and Latorre (1979) 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 pay for operating rather than fixed costs. The major operating expenses were for labor (41%) and fuel (25%). Reported fixed costs were for permits, repairs and interest on loans. However, since only about 30% of fishermen get permits, and 80% to 90% 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. (1982) 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% to their annual incomes. Smith (1981) estimates that fry gatherers earn approximately P700 /yr, and fry dealers, with the largest three excluded, earn P9,254. Fry concessions managed by the municipalities provide an average of 12.7% to annual municipal income, and employment for fry gatherers, concessionaires, dealers and nursery pond operators also has multiplier effects in the community (see Table 4). In 1976 (Smith 1981)

Table 4

Indicators of stability and integration of the fry and fingerling industries

	Gatherers	Concessionaires	Dealers	Nursery pond operators	Rearing pond operators	Fishpen operators
Years 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. Approx. no. of close competitors	na	11	14	16	many	many
B. Percent believing industry is more competitive in '76 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/mo.	5	2	5	3		
C. Percent with wide choice	30	55	77	–	na	na
D. Change since '75	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% nurs.	21% own concessions 31% own rearing ponds 10% fishpen	none	none
B. Horizontal	2% gather from more than 1 fry ground	44% have more than 1 concession; avg.2.1 fry grounds	none	23% have nurs.pnds in more than one location	27% have rearing pnds in more than one location	30% have fishpens in more than one location

From Smith, 1981, p.78

reported net returns to fry and fingerling businesses was poorest for fry gatherers, who on average earned only 70% of minimum wage. However, net returns to capital, labor, unpaid family labor, management and risk of marketing was 3.6% for concessionaires, 14.9% for dealers, and 27.7% for nursery pond operators.

Fry marketing

Fry concessions also demand high capital investment. Chong et al. (1982) estimate that the most sought-after fry grounds can demand fees of $40,000. The also say that these high costs have encouraged concessionaries to integrate vertically. Fry marketing is described in detail by Smith (1981) 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, 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 of fry from transporting over greater distance and loss of time to spend in gathering activities. Some 82% of the volume of 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 intra-regional trade flows.

From interviews of fry concessionaires in 1975, Librero estimated that 13% of the fry flow came from within the same village; 14% came from other villages within the same municipality; 38% from other municipalities within

the same province; and 35% from places outside the province. Using data collected for 1976 when fry were followed through the marketing channels, Smith estimated that 14% of the fry from Southern Mindanao, 40% in Northern Mindanao, 47% in Western Visayas, and 18% in Illocos are stocked in the fishponds in the same regions where the fry were caught. Discounting re-exports from Bulacan and Rizal provinces to other trading regions, Smith estimated that the total number of fry in inter-regional trade in 1976 was 745 million distributed quarterly as follows: 79 million or 10.7% in the first quarter of the year; 492.1 million or 66.1% in the second quarter, 111.3 million or 14.9% in the third quarter; and 61.9 million or 8.3% in the fourth quarter.

Mindanao, Southern Mindanao in particular, is the major fry exporter (62.3%) while Bulacan and Rizal provinces with no fry grounds are deficit areas with 18,095 ha 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% 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% survival over the same rearing period (Smith 1981).

When the fishpens, which must use fingerling rather than fry as stocking material, were established in Laguna de Bay, the fingerling business received a substantial boost. Price of fingerlings surged upward from P160/thousand in

1972 to P240 in 1974-76. Assuming an average stocking rate of 35,000 fingerlings/ha/yr the fingerling requirements soared to about 245 million (Smith 1981) in 1976 when fishpen area reached an assumed peak of 7,000 ha.

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 price; 2) phase of the tide; 3) weather conditions; 4) state of food supply in the pond; and 5) desired size (Librero 1976). Yengoyan (1976) states that large 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 less interested in the expense of gathering more information and be more interested in selling.

Most milkfish production (98%) is intended for the fresh fish market rather than for home consumption or processing, and the major market is the Manila area. 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 very new. There is a wide range in variation of production by region, and regional problems — distance from market, cost of transportation (truck, bus, plane), distance from market information, varying

costs of inputs, lack of familiarity with other domestic or export markets -- affect the net earnings per farm and per area. An average milkfish is marketed approximately 50 km from the farm, although Librero et al. (1977) estimate that 10% is sold in the same barrio and 38% in the same municipality. Depending upon the fishpond operator, 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 describes first sale prices ranging from P2.23 to P5.88/kg. Under direct retailing, which should be the most profitable and the most difficult to arrange for the fishpond operator, prices ranged from P3.82 to P5.69/kg. Consignment or broker selling prices ranged from P3.78 to P5.72/kg before commission (Librero 1979b). Regional differences in marketing procedures vary by a) volume of fish produced at a single harvest — a large producer profits by acting as his own broker, but a small producer does not; b) volume of fish available — a broker may have better and broader contacts for moving fish in a sluggish market; c) the personalities of the brokers and wholesalers and their reputation in the community, regional and national markets. In Quezon, 54% of fishpond operators sold through brokers (Librero et al. 1981).

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 (1979) report that because of the proximity of Central Luzon to Metro Manila, a considerable amount of all kinds of fish produced in the Central Luzon area are moved to Metro Manila. Medina and Guerrero indicated that 71% of the tilapia and 67% 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 Nicholas et al. (1976) of the Navotas fish market indicates that about 29% of the fish from Navotas were moved to the Northern provinces. A report by the Philippine Fish Marketing Authority also indicates that 20% of the port unloadings went outside of Metro Manila. Approximately 64% 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 foreign exchange earnings of the Philippines with only 1,000 metric tons in 1965 but increasing to 76,000 in 1980 (Table 5). The bulk of exports has come from tuna which accounted for almost one third of total quantity exported in 1980 and over one-half of total value. Milkfish constitutes a small proportion, but volume almost tripled for the five-year period 1975-1980. 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 (see 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% of the country's ice

plant operating capacity while contributing only 12% to total production. Region IV (Southern Tagalog), the largest contributor to total fish production, has only 159,432 metric tons of ice supply (Kampitan 1979). Librero et al. (1981) 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 lower earnings than a producer finds acceptable, and at some times (July-Oct) prices are lower than producers would like (Rondon 1979).

Retail prices of milkfish by region

Slight variations were observed in the range of retail prices for milkfish among the regions. On the average, Western Visagas 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/kg, lowest price in 1981 was P10.84/kg in Central and Eatern Visayas.

Retail prices of milkfish increased at the rate of 12 to 18% per annum. It seems that the growth in demand has outweighed the growth in supply of milkfish in Southern Tagalog. Despite the production from fishpens, retail prices still soared by 18% per year in this region.

Wholesale and retail prices of milkfish and other common fishes are being collected daily by the Bureau of Agriculture Economics (BAEcon) in 48 major trading centers around the Philippines. However, these data are only compiled at the BAEcon office and are not published. While researchers and other users can go there to copy such data, use is limited by the awareness of data users of its existence. It was observed that these data are handwritten on loose

Table 5
Selected fish exports: 1965, 1970, 1975, 1980
(in 000s kg and 000s pesos)

Product	1965	1970	1975	1980
Total exports				
Amount	1104	3407	25,988	76,179
Value	2776	17,986	327,996	939,295
Shrimp/prawns				
Amount	35	574	1672	2717
% of total exports	3.2	16.9	6.4	3.6
Value	152	7951	51,708	154,522
% of total exports	5.5	44.2	15.8	16.4
Tuna				
Amount	-	820	8120	47,290
% of total exports	-	24.1	31.2	62.1
Value	-	2519	36,616	489,951
% of total exports	-	14.0	11.2	52.2
Milkfish				
Amount	-	97	191	551
% of total exports	-	2.8	.7	.7
Value	-	388	2652	8143
% of total exports	-	2.2	.8	.9

Source: BFAR, Fisheries Statistics of the Philippines.

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	1023.1	112.9	6.7	29.1
1972	1122.4	108.9	10.7	30.5
1973	1204.8	61.4	15.8	31.2
1974	1268.4	93.8	18.2	32.1
1975	1336.8	164.4	14.8	33.3
1976	1393.5	118.0	16.1	33.2
1977	1574.0	73.0	26.1	34.1
1978	1567.0	93.9	48.4	34.0
1979	1578.0	104.1	64.9	33.1
1980	1672.2	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.

sheets which increase the probability of their being lost. Of course data collection should not end in office files. Data should be analyzed and disseminated. 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 resources in data collection. Tilapia, which has become an important species in the fish market, has been neglected, and BAEcon should add this species to its data collection process.

Income from fishponds, fry and capture fishing

Librero (1979b) has estimated that the average annual farm income is P30,953 or P2,294/ha. Most employment figures for aquaculture are based on the assumption (probably inaccurate) that one man is employed per ha. If so, average annual income from fishponds would be P2,294/man/yr. However, the assumption of one man/ha can be discounted by looking at income figures provided in various reports by Librero. From this, a caretaker could work 2 ha and an owner 6 ha at the P2294/ha income rate. Compared to small-boat fishermen (as estimated by Laopao and Latorre 1979 for Leyte) the average annual income from fishing for the boat owner was P5,100 and for crew P3,720. There are ranges of differences among municipal fishermen as well. 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% of the total. Hence, annual income was actually higher for the fishing households. Families of fishpond laborers, caretakers and owners also depended upon income sources other than fishpond production, and Librero (1976) has estimated the average annual income for caretakers to be P10,334 and for owners, four times that amount, or over P40,000/yr.

Consumption

Current (1980) estimates of population for the Philippines are 24.0 million males and 23.9 million females with more than 30% of the population less than 10 years of age and 4.7% greater than 60 years. Population growth rate is 2.64; birthrate is 30 per thousand, and as a result of estimated increases in population throughout this century, the demand for animal protein is likely to double in the next 20 years. Table 7 shows the contribution of meat, poultry, eggs, dairy products and fish — more than 50% of the protein consumed — to the diet of Filipinos surveyed from 1977-80. The table also shows the difference between average consumption by household and the consumption among families dependent upon fishing as a major source of livelihood. The implication that can be drawn from this table is 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% adequacy level) for the country as a whole, Smith (1981) estimated 70-80% of the population receives less than 50 g of protein per day. The Food and Nutrition Research Institute reports that nutrient intake levels are alarmingly low for households with annual per capita income of less than P500 and for households of farm workers and small-scale or hired fishermen (Food and Nutrition Research Institute 1979).

Milkfish have the reputation of being affordable mainly by upper and middle class consumers although important to all classes on festive occasions. Milkfish producers gear production toward fish to be harvested at 4 or 5 fish/kg; thus a single milkfish may cost P2 to P3. This must be

Table 7
Average consumption of fish and livestock products
(kg/capita/year)

	Average for all households	Average for fishing households
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. 1981, using data from 1977-81.

considered in the context of the minimum wage of P14-P18/day. However, smaller size milkfish are available on the market for less than P1 and these fish are affordable by the lower income group consumers. Income elasticities of demand for fish estimated at .22 for Metro Manila, .21 for other urban areas, and .23 for rural areas. Although the income elasticities refer to location of consumers, the locations are indicative of income level for inhabitants of Metro Manila having a higher income than other urban and rural dwellers.

To summarize fish consumption information, we know that fish is approximately 50% of animal protein consumed, and the demand for fish is high and remains high as population grows; imported fish contribute 3% of fish in the Filipino diet, while the capture fisheries provide nearly 90% of domestically produced fish. Aquaculture provides 10-11% of the fish consumed if pen/cage production is included and most of that is milkfish. Finally, milkfish production generates positive economic benefits to several income groups and to society as a whole.

ANALYSIS

Aquaculture production depends upon a range of inputs: the cost and availability of land, labor and money, a source of fry or fingerlings, water, fertilizer, feeds, and management techniques. Villaluz (1953) 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. (1982) state that, "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."

Accelerated fishpond development is a recent phenomenon; 42% of existing ponds were developed after 1966. Only 22% of the ponds now in operation existed before 1955, and 27% of ponds now in use were developed from 1956 to 1966 (Librero 1976). Productivity from fishponds is low (Table 8) but has increased at the rate of about 5% per year for the past 25 years.

Expansion to increase production

Librero et al. (1977) reported that in the early and mid-1970s, a majority of fishpond operators wanted to expand fish production area. Most of those who wanted to expand had small fish farms; only 45% of those with more than 50 ha 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 this information on the desire to extensify fish farming, there is no direct interview information on farmers who wished to

Table 8
Area, investment, employment and production of brackishwater fishponds, 1954-1980

Year	Area (000s ha)	Investments[a] (million P)	Employment[b] (000s)	Production 000s tons	Production 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

[a] Investment was based on the average development cost of P2000/ha for 1954-1972; P6000;ha for 1973-1977; and P10,000/ha for 1978-1980.

[b] Based on an average of one person/ha.

intensify production in existing pond systems. However, we assume that increases in fertilizer and pesticide use, and in fry stocking rates indicate attempts to increase production through intensification. However, Librero's (1979b) data from 1965-73 show that increases in production in that time period can be attributed to increases in total area rather than from intensification.

A decade after the information reported above was collected, Chong et al. interviewed 324 fishpond owners, of whom 56% wanted to expand production area, but were constrained by lack of capital, technical assistance, availability of land and time to attend to pond operations. Problems of lack of capital and land remained the same over the decade, but lack of manpower, fry and fingerlings were no longer as important as the lack of technical assistance and the time to manage increased operations. It is difficult to draw conclusions from this information. Can we conclude that fry/fingerling distribution systems have improved; that there is more labor easily available at the right wages, that fishpond operators have diversified sources of income, or that donor assistance would be useful in the area of technical assistance?

Chong et al. (1982), in a detailed study of the economics of the milkfish production system, hypothesized that variations in production could be explained by the following variables: age of pond, number of milkfish fry stocked, number of milkfish fingerlings stocked, acclimatization time before stocking, man-hours of hired labor, miscellaneous operating costs, operator's years of experience, pesticide use, organic fertilizer use, inorganic fertilizer use, and farm size. Their data was based upon interviews with 324

producers in 7 provinces. Only producers who used inputs were interviewed; thus the data does not compare progressive farmers who use technology with those who do not, but rather it compares users of inputs to see which inputs affect production. The general conclusion from the analysis was that because absolute values of the estimated production coefficients were low, the response of milkfish output to supplemental inputs was low. However, the researchers readily admit that the values they used as representatives for other inputs could be improved in future research. As this information is reported, we contrast it with conclusions drawn by other researchers, particularly Librero et al.(1977 and 1981).

Chong et al. found that variables were significant on a per hectare and per farm basis. Age of pond was a significant variable which the pond operators attributed to the 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 — the latter slightly less so. Miscellaneous operating expenses which represent 22% of operating costs and are a catch-all for repair and maintenance costs, food for laborers, depreciation, rental, and interest, were significant, but because the data were grouped, the possibility of one item being a useful indicator for production was masked.

Organic and inorganic fertilizers were significant although not greatly different, and Chong et al. conclude that these fertilizers are not used in large enough quantities to affect yield in a way big enough to measure. In contrast, earlier work by Librero et al. (1977) shows that fishpond operators using fertilizer averaged 832 kg/ha/yr versus non-users who produced 285

kg/ha/yr. The conclusion readily drawn is that fertilizer use increases production markedly, but these data may be misleading since they are reported without taking into account farm size or other variables.

Farm size is significant on a per farm basis according to Chong et al. although there was a difference between privately owned and leased farms; increases in the size of privately owned farms contributed more to production than the same increase in size of leased farms. In addition, economies of scale were positive, indicating that the average size farm (16.2 ha) could achieve economies of scale and increased profits by increasing level of inputs.

Chong et al. also reported on a number of variables they found not to be significantly correlated with production. Acclimatization of fry and fingerlings did not affect production levels when number of hours of acclimatization was used as the input. A better measure might have been difference in temperature, salinity or pH. That detail was probably not available since they state the "purpose and process of acclimatization is not clearly understood by the farmers who practice it." Hired labor was not significant because it was not a good measure of total labor input, and it did not take family labor into account. Years of milkfish farming — intended as a proxy for management experience — was not significant and they conclude that "recent information in improved methods of production is, apparently, either not reaching the majority of milkfish producers, or not being adopted by them." A better measure of management may be pond construction or layout, ability to control water, fertilization programs, and/or sources of marketing information. Application of pesticides had no statistically significant effect although fish farmers claim the use of pesticides was important. In

this analysis, the cost of the pesticide applied was used as the measure of input. What the analysis probably indicates is that all producers used very close to the same amount of pesticide - and without a difference in the amount used, the statistics reported the variable as insignificant. Perhaps the type of pesticide ranked by known effect would have been a better measure. Librero et al. (1977) state that farms that used pesticides averaged 338 kg/ha higher yield than farms not using pesticides (see Table 9).

Chong is completing research on "constraints to higher yields of milkfish farms in selected areas of the Philippines, 1981." That survey asks for more detail on the variables which were significant in the report summarized above, data on government loan programs, value and frequency of extension work contacts, whether the owner is full or part time, and occupational history. The degree of vertical integration should also be measured as a possible variable in predicting pond production. Table 4 shows that fry concessionaries, dealers and nursery pond owners also own fishponds.

Other correlations might also be examined. For example, Librero et al. (1977) state that fishpond operators with bigger fishponds tended to be more innovative in their operations because of bigger risks involved. The question arises as to whether innovative people are attracted to big fishponds 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 ha range.

Two of the non-significant variables — pesticides and management practices - probably have had a significant impact on production even though this research does not indicate their benefits. The method measuring the

Table 9
Annual costs and returns per hectare by use of fertilizers, by region[1]
(in pesos per hectare)

ITEM	REGION I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Phil.
Did not use fertilizer												
Total receipts	3471	2275	1186	1243	1199	2390	622	1205	778	1258	1550	1270
Total expenses	1258	533	846	896	510	1164	468	459	354	480	1166	646
Net return	2213	1742	340	347	689	1226	154	746	424	778	384	624
Did use fertilizer												
Total receipts	3650	1750	2843	1870	922	3032	1157	1521	599	1854	2510	2668
Total expenses	1860	920	1998	1091	474	2046	722	738	323	873	1704	1755
Net return	1790	830	836	779	448	986	435	783	276	981	806	913
Used organic fertilizer												
Total receipts	2814	1760	3148	2356	903	1731	752	1155	841	1398	3934	2358
Total expenses	1880	1344	2490	1557	438	976	559	448	429	912	1608	1760
Net return	934	416	658	799	465	755	193	707	412	486	2326	598
Used inorganic fertilizer												
Total receipts	3742	2856	2550	1263	1019	3118	1318	1556	476	1698	2331	2628
Total expenses	1803	1865	1522	545	598	1706	869	767	308	606	1604	1473
Net return	1939	991	1028	718	421	1412	449	789	168	1092	727	1155
Used organic/inorganic fertilizer												
Total receipts	3241	1682	2944	2998	917	3032	2710	-	304	4046	3366	2914
Total expenses	2159	758	2212	2059	545	2258	1081	-	147	1218	2479	2123
Net expenses	1082	924	732	939	372	774	1629	-	157	2828	887	791
Average for all ponds												
Total receipts	3625	1816	2517	1683	1031	3008	1026	1293	701	1364	2394	2294
Total expenses	1782	873	1776	1032	486	2015	659	536	339	549	1637	1458
Net return	1843	943	741	651	545	993	367	757	362	815	757	836

From Librero et al. 1977.
1 See page 115

variable needs greater consideration in further attempts to correlate production with inputs. In experimental settings, pesticides have been shown to have a marked effect on all levels of pond productivity.

An alternative to Chong's approach is to take a broader perspective of the effects of aquaculture development on the Philippines. With data from Librero (1979a), the Development Bank of the Philippines (DBP) and BFAR, we analyzed fertilizer use, production, earnings, labor, extension workers, and bank loans provided by the DBP. See Table 10; a Pearson Correlation was performed; only data significant at p less than .05 is discussed.

Fertilizer use was significantly correlated with gross earnings per ha of fishpond, but not with net earnings. The implication is that the cost of fertilzer is high — higher than a fishpond operator can be expected to recover when he markets his fish. We also found that a combination of organic and inorganic fertilizer use was more likely in the regions where DBP loans were largest. Unfortunately, we cannot tell from this information whether the DBP policy was to loan to farmers who knew how to use fertilizer or whether the loans provided the farmers with enough money to buy fertilizer.

The analysis of average fish farm size compared to all other variables showed that size was related to gross and net earnings, and negatively correlated with the amount of 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 data also shows that a larger proportion of owner-to-caretaker time does not affect production (kg/ha) or earnings. This is contrary to the comments made by fishpond operators with whom we spoke. However, production was positively

correlated with the amount and number of loans given by the DBP, although net earnings were not. This means that fishponds supported by government loans provided more fish, but have not improved the incomes of the fishpond operators. This could be an artifact of the distribution of DBP loans. Table 10 shows that most loans are given in Region VI where the problem of marketing increased volumes of milkfish may result in lower net incomes.

The number of extension workers was not positively correlated with anything except the number of man hours spent per ha per year. From this, we could hypothesize that extension workers have communicated information on the details of preparing fishponds, fertilizing, etc., and that their efforts have resulted in more man hours spent. However, the number of extension workers may indicate government's interest in expanding fishpond production, but it cannot be used as a proxy for the quality or effectiveness of extension work.

Serious questions have been raised on the accuracy of aquaculture statistics on area, production and yield. Fishpond area has remained constant through the years, and total production is estimated based on a survey of production per ha per province done by the Bureau of Fisheries and Statistics in the late 1950s. Any inaccuracies in the area and production data are reflected in the yield per ha. 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 reports which may be done at different periods at specific locations. Thus, systematic time series analysis on a regional basis cannot be done.

Table 10
Fertilizer use, farm size, earnings, labor and loans for 1975

Characteristic	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
Avg. size of farm (ha)	3.26	10.28	17.34	4.94	9.21	13.17	4.87	33.33	17.28	34.98	9.28
Avg. kg/farm	2,307	3,402	10,608	2,323	2,391	11,888	1,407	10,613	2,921	13,988	4,769
Avg. gross earnings/farm (in Pesos)	15,318	18,646	52,634	9,834	11,082	49,279	5,723	46,520	13,376	53,066	28,393
Avg. gross earnings/ha	3,625	1,816	2,517	1,618	1,031	3,009	1,025	1,292	701	1,363	2,394
Avg. 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
Avg. net earnings/ha	1,843	994	742	651	544	994	367	755	361	816	756
Avg. 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
% time spent by owner[3]	.49	.45	.12	.16	.30	.14	.31	.03	.19	.02	.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	.420	1.149	1.535	2.773
No. of DBP loans	46	37	54	179	25	232	19	6	11	16	56

[1] Organic, inorganic, combination; [2] data for 1974; [3] % time spent by owner/owner + caretaker.

GOVERNMENTAL FACTORS

The Philippine National Development Plan estimates that fish production will expand at the rate of 5.6% per year from 1978 to 1982, and the level of domestic fish supply is to increase from 1.6 million to almost 2 million metric tons. By 1987 fish supply will need to increase further to 2.4 million tons. While Municipal fisheries will still account for the biggest share of total fish production, the assumption of the plan is that, while coastal capture fisheries will increase at an annual rate of 4.6% per year, the greatest expansion will come from aquaculture, which is expected to grow at 9.8% per year. What is the probablility of that growth continuing now that limitations on further development of mangrove areas exist? What is the potential for brackishwater production, 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). The quality of the government's national programs for country development generally and aquacultural development specifically were considered.

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. Government loan programs as they now operate are a long-term constraint to economic development of fishpond businesses. The banks are inherently conservative; their loans are limited to P25,000 to P30,000/ha which is less than projected needs by fishpond operators in several

regions where the cost of land, labor and other inputs is high — for example in Capiz where P40,000/ha is needed. Government policy makers and planners realized this problem and initiated steps to provide the needed financial support to the industry. The Development Bank of the Philippines (DBP) is the main source of credit for economic development for small, medium as well as large-scale industries, including those in fisheries and aquaculture. The DBP acquires funding from external sources such as 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 charged with providing loans for small-scale fisheries including a number of aquaculture ventures. The latter bank is also authorized to support selected fisheries and aquaculture projects. The Agriculture Credit Administration can provide funding for aquaculture projects through cooperatives. All these government credit institutions are supplemented by funding support from private banks in the country. It has been noted that the W[illegible] 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 just completed in 1982, and 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 in this field have failed, there are a few successful examples which may become models for future development.

The Languna 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

There are two socially-oriented government programs recently initiated with heavy involvement in fisheries and aquaculture. These are 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 engaged in 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 for mussel, oyster and seaweed culture), pond construction, operating costs, freshwater species cultured in small ponds (from 1/2 to 1 hectare), and for operating costs of brackishwater fishponds smaller than 10 hectares. The funding is to be distributed upon application through the network of rural banks. For various reasons, this program has been observed to be only partially successful.

The KKK program began in August 1981 and 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, owned and managed by the community residents, and includes a wide range of projects such as agroforestry, agrolivestock, aquamarine, waste utilization, cottage and light project industries, shelter materials, and aquaculture. The list of possible aquaculture projects include: communal fishfarm estates (using ponds, pens or cages), communal fish hatcheries and seafarming of oysters, seaweed and mussels. Target groups or priority beneficiaries include landless workers, subsistence fishermen, urban slum dwellers, minorities, out-of-school youths, disabled persons, and others. Local officials are mobilized to assist in the program, and the national extension services also take a very active part. KKK project recipients receive technical, marketing, training, infrastructure support, and project development and management assistance for each enterprise. The program appears to have strong government commitment and support as is reflected in the fact that the national committee is of highest level and includes a national secretariat.

Support services for aquacultural development

There are a number of other government agencies that have provided or do provide full or partial support for aquacultural development. The number of these has increased over the years, but some were active in the 1930s. For example, prior to World War II the government established the National Foods Corporation as a subsidiary of the National Development Company. The aim of that corporation was to develop a sizeable brackishwater fishpond project and demonstrate the commerical operation of a vertically integrated venture. It included a fishpond project of a few hundred hectares, equipment and facilities for a cannery for processing the products, and the machinery to market, handle and distribute the processed products. After a few years of operation, World War II began, and during the war some of the facilities were destroyed while others deteriorated. Although it initially showed encouraging results, the project was abandoned after the war and the ponds reverted to the private sector.

PUBLIC SERVICE INSTITUTIONS

In recent years there have been many technological, social and economic changes that encouraged Philippine fish farmers to intensify and increase fish production efforts. This section describes the major changes in public institutions that have occurred during the evolution of the aquaculture industry. These institutions are grouped here in one of four categories: administrative, educational, research, 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 record the existence of certain forms of aquaculture in the Philippines during the early 16th Century, and it was probably practiced in the early 15th Century. However, there are no records of specialized government fisheries agencies or 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 (Bleeker 1865, 1874, 1877; Boulenger 1895; Cartier 1874; de Elera 1895; Gunther 1872; Steindancher 1864, 1867, 1893).

Agencies were first charged with fisheries responsibilities during the United States regime (1900-1946). After one year of US military rule, the Philippine Commission was established on July 4, 1901, and began a civilian government. One Commission policy was to develop the country's fishery

resources, and in 1907 a Fisheries Section was organized in the then Bureau of Government Laboratories. The office was staffed by one person (an expatriate named Alvin Seale) because of lack of trained personnel and limited funds. However, the Commission was able to request the U.S. government to dispatch the research vessel Albatross for an oceanographic and fishery resource survey during the period from 1907-1910.

The Bureau of Government Laboratories was later expanded and reorganized into the Bureau of Science, and the Fisheries Section became a Division of Fisheries within the Bureau. 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 the Forest Fauna and Grazing function to the Bureau of Forestry and the Zoology function to the Bureau of Science.

During World War II, which began in December 1941, Japan occupied the Philippines from 1942-1945. During the early part of the Japanese period, a Bureau of Forestry and Fishery was created (1942-1943). Later (1944) fisheries functions were assigned to a separate office called Bureau of Fisheries.

After the war, and with American Commonwealth rule, the old Division of Fisheries in the Department of Agriculture and Commerce, later reorganized as the Department of Agriculture and Natural Resources (DANR) was restored.

Philippine independent rule started in 1946 with most of the established administrative offices including fisheries being continued during the change from American rule to independent government.

An enlarged fisheries office called the Bureau of Fisheries (BOF) was organized by Republic Act No. 177 on July 1, 1947. By this time the Bureau was much expanded and included the Philippine Institute of Fisheries Technology and seven secondary fisheries schools. Later reorganization took place on January 16, 1957, and 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 then reverted to the old name - Bureau of Fisheries in 1972. In 1974, with a shift from a presidential to a quasi-parlimentary government, the various cabinet rank departments were converted into ministries. Agriculture and Natural Resources was divided into two ministries: of Agriculture (MOA) and 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 also have partial responsibility for aquaculture. The different Fisheries Regional Offices are involved in aquaculture and may have specific units for aquaculture work.

Fisheries policies are formulated through the Fishery Industry Development Council, one of the agencies 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," 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 in the implementation of these programs.

Educational institutions

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

The following excerpt from Mane (1952) describes early training development in fisheries:

> "College training in fisheries work was intitiated 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 three 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 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 ten students started the fisheries course which graduated its first class of six in 1940. The program was then disrupted by World War II and did not resume after the war. Mane was among Dr. Villadolid's first students in 1927, which also included F. Alonte, F. Arriola, D. Bunos, P. Manacop, and A. Nono among others. The intial 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 1920s including H. Montalban, F. Talavera, J. Montilla, G. Ablan and G. Blanco. In

1937 when the UP College of Liberal Arts in the Manila campus started courses towards a Bachelor of Science in fisheries, they included major options such as fishing methods, fish culture and fish preservation. There were six graduates from the first course in 1940, but when the war broke out the following year, the course was discontinued. The six original students were divided among the majors, and two each graduated for fishing methods, fish culture and fish preservations. When the UP resumed classes during the Japanese Occupation and after independence, the baccaulareate course in fisheries resumed to allow previously enrolled students to graduate but no new students were admitted because of inadequate funds and lack of facilities. A total of 18 graduates completed 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 three months before it was forced to close as a result of increased intensity of the war. The school was reopened in 1946 offering a 2 1/2 year practical curriculum for a diploma in either fish capture, fish culture or 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 and not a school which rightly belonged to the Department of Education. They offered college-level instruction to graduates of recognized high schools, and had 40-50 students enrolled each year. Students in the Institute were regarded as of normal ability, choosing the school because of low cost and the hope for employment upon graduation. Tuition was free. The fish culture course was practically oriented and used the Bureau of Fisheries experimental farm at

nearby Dagatdagatan lagoon for laboratory work. Students in fish culture also had to complete a 6-month practicum with a commercial fish farm or similar experience as part of their training. About 15 students, mostly male, were in each class. Graduates generally went to work for the Bureau or in one of the regional or vocational fisheries schools; a few went to work on family-owned or other private fish farms or left the fishery sector completely.

Regional and vocational schools

In 1949 seven vocational fisheries secondary 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; Nasugbu, Batangas Province. In 1957, the Bureau was reorganized, and the 14 secondary fisheries schools were transferred to the Bureau of Public Schools in the Department of Education. It was at this time that the Institute of Fisheries Technology also was transferred to the UP and became the UP College of Fisheries (UPCF) in Diliman, Quezon City. Additional secondary fisheries schools were established, and others were expanded and upgraded to become regional fisheries colleges (e.g. Zamboanga and Tabaco). By 1977 there were five such programs offering degree or diploma (post secondary training) with a total enrollment of 1500 students. Although facilities for fisheries education expanded consistently in the decades since World War II, it is doubtful that much of the training dealt with aquaculture.

A decision was made in the early 1970s to consolidate and upgrade education and training in the Philippines. The Educational Development Projects Implementating Task Force (EDPITAF) was created for this task. All levels of fisheries education and training have been included in this

program. At the same time, a system of fishery secondary schools developed across the country. In 1975 all secondary schools adopted the same core curriculum recommended by a national task force. By 1977 there were still almost 70 "fishery" secondary schools although they used the common comprehensive national curriculum; fishery subjects were covered during practical arts, about 10% of the overall learning time. About 20,000 students were enrolled in these fishery high schools.

UP College of Fisheries

The UPCF started the 2 1/2 year diploma courses in 1957 and continued to offer those courses while adding a 4-year BS in Fisheries, with majors in marine fisheries, inland fisheries, and fish processing technology. In the 1980-81 first semester the Diliman campus had enrolled 140 students in the fish culture diploma course and 100 students in the BS major in Inland Fisheries course, with a Department of Inland Fisheries Faculty of 13.

In 1974 with establishment of the UPCF Brackishwater Aquaculture Center (BAC) in Leganes, Iloilo, a joint B.S. Fisheries major Inland Fisheries degree program between the UPCF-BAC and the U.P. Iloilo Campus was intitiated. First semester 1980-81 had 47 regular students 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 non-thesis Master of Aquaculture program has also recently been added to the UPCF offerings. Currently U.P. programs in the Iloilo area are being consolidated to form a new unit called the U.P. Visayas

(UPV). A new campus headquartered at Miag-ao, Iloilo, will include the BAC and the U.P. Iloilo College of Arts and Sciences, and will focus on fishery training. The UPCF is scheduled to move to Miag-ao by mid-1983, although there is some resistence to this move. Counter proposals are being suggested by staff based 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 enrollment for the 1981-82 year has averaged 52 students, of which 23 are female; 17 are foreign-sponsored, and 32 receive domestic support (principally from the Philippine Council for Agriculture and Resources Research and Development). Shuttle transportation service 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 MS program: 17 by females and 5 by foreign students: 3 from Indonesia, 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 BS curriculum. This led to the creation of a department and now 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 the first semester 1978-79, 233 in the first semester of the 1980-81 schoolyear. This is a time when the enrollment in the

common first year for all undergraduate programs has declined from 1418 to 845 (40% reduction in 2 years), a trend also seen in other state colleges and universities in agriculture. Major contributing factors to this downward trend, also likely to affect student representation in fisheries, are "1) inflation and high cost of transportation; 2) the shift in the demand for non-agricultural graduate praticularly 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 (Campos 1981)."

Other schools

In the 1978-79 period, 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 is to continue as the regional fishery school for Luzon, and Mindanao State University is to serve the southern region. The UPV is 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 curriculae in fisheries to provide core staff for research and for the faculty.

As a second level of higher education, seven Regional Institutes of Fishery Technology have been identified to give technical post-secondary diploma courses (phasing out their BS Fisheries programs if already established) and presumably calling for the phasing out of fishery programs in

other regional technical colleges. The Regional Institutes will train extension workers and technicians for various industries in fisheries including that of aquaculture. They are:

Cagayan State University College of Fisheries	Aparri, Cagayan (Region II)
Palawan National Agricultural College	Puerto Princesa, Palawan (Reg. IV)
Bicol University College of Fisheries	Tabaco, Albay (Reg. V)
Quirino School of Fisheries	Carmen, Cebu (Reg. VII)
Samar Regional Fisheries Technical School	Catabalogan, Samar (Reg. VIII)
Mindanao Regional School of Fisheries	Zamboanga, Zamboanga del Sur (Reg. IX)
Davao del Norte School of Fisheries	Panabo, Davao del Norte (Reg. XI)

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

Discussion

The GOP has made considerable commitment to fisheries education as is appropriate given the importance of fish and fishing in the country. Filipinos are generally education-conscious so that families 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; it

may be incidental that the subject of study is fisheries. Fisheries education has been relatively inexpensive, and, at least in the case of the UPCF, until recent years had reduced admission standards. This means that students of limited financial resources (such as girls in families where first priority in the education budget 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 in the private sector. Many private producers contend that "costly school-learned techniques" are behind their own current practices, and they tended to stigmatize recent graduates as being ill-trained. The same stigma carried over to graduates if they found employment in extension work. Those finding work 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) that received post-graduate or other advanced training, have been in great demand as educational and other public sector programs have expanded. These people have generally 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 development of research programs meant that there had to be a faculty that could staff academic programs. The high-level training of the staff plus their research activities have also provided a new infusion of information valuable to the private sector. Graduate students provide much of the manpower used in the day to day operation of research projects. Thus

we conclude that a vital research program is a key to a decent fish culture educational program.

Non-academic 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 groups such as vocational school teachers, farmer extension programs, KKK programs, and others. The applications from students outside the country also suggests a greater importance than just nationally.

Research institutions

Early aquatic research in the Philippines was confined to taxonomic and observational reports. Most prolific in publishing such descriptions 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 (Herre and Mendoza 1929) stands as a benchmark for the state of the industry at that time. Other descriptions followed in later years (e.g. Adams et al. 1932, Carbine 1948, Bardach et al. 1972).

The Bureau of Fisheries had the early responsibility for applied research. They 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 appears to be destined for closure 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 that started some experimental work with freshwater fish hatching.

Milkfish pond culture experimental research 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 75 ha plus about 30 ha of adjacent leased pond area. Work at the station dealt with the effects of stocking rate, fertilizer, feeding and species combinations. Urban encroachment resulted in siltation and pollution of the waters so the station was eventually closed in the mid-1970s. 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.

Starting in the 1950s the Bureau of Fisheries established a network of fish culture field stations around the country. There are currently about 40 brackishwater, 31 freshwater, and several sea farming trial sites that have served primarily for demonstration and training purposes. From time to time there have been attempts to do research at these units but, with a few exceptions, the output of published results has been negligible.

Basic biological research was conducted in a modest way during the 1950s and 1960s at the universities and in public agencies. UPCF established a research arm, called the Institute of Fisheries Development and Research. Mindanao State University conducted some shrimp culture research in the late 1960s. The Laguna Lake Development Authority concentrates on biological studies, gathering statistical information about lake fisheries, and described a variety of product uses for fish.

In 1971 the Philippine Government initiated strong effort to develop research capacity 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 station. The National Science Development Board provided the major local financing for the project that also received USAID

support for overseas staff training, equipment and technical assistance. Because of the research nature of the project, the UPCF, through its Institute of Fisheries Development and Research, was designated the overall implementing agency, with CLSU being a partner in the establishment of the freshwater station component. The research stations were officially designated in the mid-1970's as the Brackishwater Aquaculture Center under the UPCF and the Freshwater Aquaculture Center under CLSU.

Brackishwater Aquaculture Center

The municipality of Leganes in Iloilo Province provided 40 ha of municiple-owned traditional brackishwater fishpond land to the Inland Fisheries Project for development of the brackishwater research station. Pressure from an enthusiastic group of local fishpond operators helped secure the site for the station. Initial construction involved excavation and diking of the land into series of small research ponds. In addition, modest laboratory structures were built. Although the physical development has been hampered by a variety 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 hold 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 research areas: culture systems, fry-fingerling survival, use of agricultural by-products, and acid-sulfate soils. They also have special programs for pesticides and the environment, energy, parasites and diseases, and are hoping to develop some work in fish breeding and genetics.

Freshwater Aquaculture Center

The location of the freshwater station under the Inland Fisheries Project at CLSU resulted principally from the willingness of President 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 a suitable site on Mindanao were frustrated by the distance from Manila and the questionable peace and order situation there. The initial station, with 60 small research ponds, 500 and 100-m^2, and a laboratory building, was inaugurated in 1973. Additional ponds, buildings, and a rice-fish experimental area have been developed since. 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 the SEAFDEC work was to be in shrimp production research principally with assistance of the Japanese government. A 10-ha site for pond development adjacent to the Inland Fisheries Project site in Leganes, Iloilo, was reserved for SEAFDEC. They also secured land on the coast at Tigbauan, west of Iloilo City, where they have developed an expansive research and training facility. Additional land was leased at Leganes and additional pond area and buildings have been constructed there. Besides work on the biology and cultivation of shrimp, the Aquaculture Department has worked on the reproduction of milkfish and a broad variety of other research projects with crustaceans, mollusks 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, as part of its research division, 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 mollusks. The department is led by three research associates (M.S. degrees).

Philippine Council for Agricultural Resources Research Development

In November 1972 the Philippine Council for Agricultural Research was created by presidental decree as a central coordinating agency attached to the National Science Development Board and through which all governmental sponsored agricultural research needed to be approved. 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 has the charge not only to approve, but also to help plan, fund, develop capacity, and publish research activities. Its secretariat is housed at Los Banos and 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 has been formed on which local researchers serve part-time to plan, coordinate, review and evaluate research programs in their respective commodity area. In fisheries there is a separate commodity team each for marine fisheries, aquaculture, and inland fisheries.

Priorities for aquacultural research, including socio-economic as well as biological topics, have been developed and updated through national workshops convened for this purpose. Where needed, the Council can commission research required to address these priorities or provide scholarships to generate research skills related to priorities, even if not the source of financing.

For the period 1973-1981, the Council lists 283 completed projects in aquaculture in different disciplines by different agencies. In addition there are approximately 85 on-going projects approved beyond 1981 (PCARRD 1981). Budgetary requirements for all approved aquaculture projects from all sources in 1981 totaled approximately P4.5 million. Of this, 40% was from the Council's budget, 29% from the National Science Development Board and 16% came directly from implementing school budgets; 6% came from BFAR, 5% came from the Natural Resource Management Center, and 4% came from the Bureau of Agricultural Economics (BAEcon). Of the combined NSDB-PCARRD budget for aquacultural research projects in 1981, 51% went to CLSU, 29% went to the UP System, and 18% went to other institutions to fund projects on the culture of seaweed and on the controlled breeding of migratory fishes in Naujan lake. To develop research capabilities in the national research network, the Council is providing scholarships for BS, MS and PhD degrees in aquaculture and related fields.

Discussion

The research facilities for aquaculture built over the past decade in the Philippines are certainly impressive. The number of experimental ponds and research laboratories built or under construction is formidable; physical facilities should not be a limiting factor on research productivity 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 are 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 a setting for research reports. Their respective newsletters and publications have generated a considerable amount of travel and information exchange between individual 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 there were 334 members, about one-third of which designated an area of aquaculture as their special interest. A semi-annual journal, the Fisheries Research Journal of the Philippines, is published by the Society and has already published 5 volumes.

A major problem in aquaculture research and development is the lack of well-trained leaders in the field, particularly at the PhD level. At each of the research centers we visitied, (CLSU, UPV and SEAFDEC) concern was expressed about this problem. Because the centers have grown so rapidly, there are not enough well-trained people to do all the research, teaching and administration required. The problem is worsened by low pay scales at the universities or in government and the lure of special high-paying consultancies at home and abroad. Funding agencies have tried to counter with honoraria for those helping with specific research projects, but this has not

been adequate. The pattern that is emerging is for research to be done in abstencia, 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 research reporting. Obviously, this pattern is not unique to aquaculture or to the Philippines, but the problem is, nevertheless, of real concern when considering the quality of aquaculture research for the future.

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 functioning both within the central office and in each regional office. The following excerpt (FIDC Integrated Fisheries Development Plan for the 1980s, 1981) 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) Techical 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 handline, storage, transport of fish and on the various processing technologies such as drying, salting, smoking, deboning, etc."

BFAR has a large number of programs associated with its aquaculture extension program. 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 attention 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 technical preparation of loan requests and to provide technical assistance to borrowers who have secured loans for fishpond 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 have also been directed to help the BFAR aquaculture extension effort: FAO's United Nations Development Programme-sponsored Brackishwater Aquaculture Development and Training Project,the USAID-assisted Freshwater Fisheries Development Project and the Aquaculture Production Project, the World Bank/EDPITAF Fisheries Training Project, the US Peace Corps Fishery Volunteer and Japanese Overseas Cooperative Volunteer programs, are the most significant recent projects.

Several other agencies have functions that overlap BFAR aquaculture extension. For example, the Laguna Lake Development Authority has been given 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 literature for extension use such as the Philippines Recommends series with booklets on milkfish, oyster and mussel, and tilapia culture and the Technology series with issues 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 it lends extension support in programs using water, animal feeds, farm credit, fertilizers and pesticides that have direct links to aquacultural applications. The three major universities with aquaculture programs, UPV, CLSU and MSU, all have extension responsibilities in their legal mandate, and MSU even offers a BS Fisheries degree with major in extension.

In several areas there are fish producer associations which provide information exchange. Probably most notable of these is the group in Iloilo that has worked successfully for more than 20 years and now holds training programs for caretakers and smaller fishpond operators. The Iloilo and other such groups are now joined together with a regional and national federation of private producers that holds an annual conference where there is free exchange on technical and political matters influencing the aquaculture industry.

In the past the BFAR extension program has not been very effective. Many of the extension workers have been uninterested or unable to move about in the field; others have been political appointees given patronage jobs without training or expectations for performance in their work. Even those with technical training in production techniques and extension methodology have not received adequate educational materials or budgets to get them out of their offices and into the field. Progressive fish farmers have generally felt they

were more informed than the extension people and had little to gain from the seldom-seen and poorly prepared fisheries extension workers.

Nevertheless, the impact of extension can be seen in some ways. For example, foreign advisors have been used in training by the BFAR and seem to have provided credibility in the effort to promote the use of fertilizers, proper pond layout and construction, care in the handling of fish as well as other management techniques. Peace Corps Volunteers have given vitality to extension activity where they have been stationed with BFAR. The recent spread of seaweed culture, tilapia production, pen and cage culture, and rice-fish combinations has certainly been facilitated by extension programs. The operation of the FAC, BAC and SEAFDEC research programs has also provided worthwhile information for extension workers to 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 progress in development and improvement of culture techniques has been attained. One reason for such progress is the assistance provided by outside agencies and donors, which include the United Nations and its family of agencies, established international and regional institutions, and bilateral donors. All these agencies are concerned with technical assistance which can be in the form of technical advisors, commodities, equipment, and/or training. The second type of assistance is in the form of funding or credit, generally from the World Bank or from regioal 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 Organizations (UNESCO) has supported research or training programs in the field of fisheries, aquatic resources or aquaculture. The United Nations Children's Emergency Fund, through its Applied Nutrition Program projects, has also assisted in the production of food fish in the Philippines. 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 a long history of assistance for 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 which stimulated the improvement of culture techniques for brackishwater fishponds. Overlapping this project was the Freshwater Fish Culture Project from 1969 to 1971. This freshwater project 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 currently active project provides technical assistance, commodity and in-country training services. Under this project, four demonstration stations in each climatic zone of the Philippines were established. Manuals for training and extension work have been developed, and new extension workers as well as former extension workers are being trained.

FAO is also involved in regional and interregional projects involving aquaculture in the Philippines. 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 in Asia. The centers include the Brackishwater Aquaculture Station at SEAFDEC in Tigbauan, Iloilo. The other centers are in Thailand, India, and China.

Southeast Asian Fisheries Development Center (SEAFDEC)

SEAFDEC Aquaculture Department, established in 1974 in Iloilo, has built extensive facilities for research and training in various aspects of aquaculture. Facilities for specific research such as the Fish Nutrition Laboratory are still under construction. The Aquaculture department has a

core staff which provides regional training programs for participants from member countries. Participants from countries outside the region can be accomodated by special arrangement. The Japanese government has provided substantial contributions to the program in facilities, equipment and funding. The Philippines contributes P30 million to the Aquaculture Department, 22% of the GRP aquaculture budget, for infrastructure: facilities for maintenance and operations; salaries of personnel. The Department cooperates with the UPV/BAC unit in Iloilo in providing facilities and training for graduate students in the program in aquaculture. The department also cooperates with FAO/Network of Aquaculture Centers in Asia by hosting 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 has several sub-stations: a shrimp hatchery at Batan, Capiz Province; a marine sub-station at Igang, Guimaras island, Iloilo Province; and a shellfish culture sub-station at Himamaylan, Negros Occidental Province. Since its establishment, the SEAFDEC has made substantial contributions in advancing studies in the biology and controlled spawning of milkfish; in hatchery and mass production of penaeid shrimp post-larvae, and in culture techniques for various other species. It has financed a comprehensive socio-economic survey of the aquaculture industry in the Philippines. And it has conducted international and national training programs on various projects including hatchery, culture management, and aquaculture engineering. Assistance to support its varied research and training projects is from the International Development and Research Centre of Canada, the New Zealand government and others.

The International Center for Living Aquatic Resources Management (ICLARM)

ICLARM, founded in 1975, is an autonomous, non-governmental research institution with programs in aquaculture, fisheries, resource development and management, education and training. Although international in scope, the Center has focused in Southeast Asia and the Pacific Basin. ICLARM headquarters have been in Manila since 1977. It is difficult to assess ICLARM's contribution to aquacultural development in the Philippines. The Center's professional staff is small but productive. We observed that the performance of ICLARM and its presence in the Philippines is highly thought of. Filipino professionals use the Center staff and library both formally and informally. ICLARM publishes five technical series and a newsletter which contain research reports and information specific or relative to the Philippines. ICLARM has cooperated with Philippine institutions on a number of aquaculture projects summarized below:

Cooperating Institution	Project Title
Freshwaster 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
Philippine 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)

USAID has been involved since 1971 in 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 projects was to improve nutrition of the Filipino people by helping develop the country's potential for increasing production of fish through aquaculture. The objectives of the projects focused on development of three institutional capabilities or services — research, academic training and extension — considered essential to the aquacultural development process in the Philippines.

To accomplish the objectives, the IFP (FY 1971-1974) concentrated on establishment of two research training centers, the Freshwater Aquaculture Center at Central Luzon State University and the Brackishwater Aquaculture Center in Iloilo Province. During the project, 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 (FY 1975 through March 1979) focused on continued physical development of the centers, intensification and expansion of research effort, and extablishment of academic and applied training programs. The project also sought to institute an effective extension program within BFAR and to link extension with the research/training centers.

The FFDP (FY 1979 and continuing) addresses intensification and expansion of extension effort, development of a fish hatchery with high volume (up to 20 million seedlings per year) production and distribution facilities, and a market development and consumer education program.

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

Accomplishments of the projects include the following. Complete research/training facilities were established allowing the creation of the BAC and FAC. Effective research programs were established. Under 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 duration; 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. An Extension Division was established in the BFAR. A comprehensive technology diffusion program was established involving 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 in establishing the institutional components fundamental to sustained development of the country's aquacultural potential. These projects have made possible other development assistance efforts that otherwise would not have been available to the Philippines. However, aquacultural development in the country is in an immature stage and continued, sustained progress is not guaranteed.

Other Bilateral programs

The Philippine government has received assistance in fisheries and aquaculture projects either directly or indirectly from a number of other sources in bilateral arrangements: 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 support is difficult to assess because information about earlier training efforts is limited and we lack standards against which to compare the various training programs. From 1947-1949 a total of 122 men and 2 women were sent to the U.S. for a year each for special training in fisheries under the U.S. Fish and Wildlife Service, Philippine Fisheries Rehabilitation Program. We have been able to trace 67 of these individuals: 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 in non-fisheries government agenices, 5 found work with international agencies, 4 died early in their careers and 2 immigrated to the U.S. If we assume that the individuals we were unable to identify 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% worked in fisheries outside the government or outside the Philippines. At least 7 have spent some time working for FAO. Several have risen to significant positions, particularly in the Bureau of Fisheries.

Under the Inland Fisheries Project and Aquaculture Production Projects (1971-1979) with USAID assistance, 18 Filipinos were trained in long-term (18-24 months) and 10 Filipinos were trained in short-term (1-6 months) programs related to aquaculture. Of these trainees, all but three have returned to their respective agencies and are still employed; one has resigned and emigrated to the U.S., and one has resigned to enter private consulting

and business. Several of those still employed remain under obligation to serve three years employment for each year of study leave. Those with advanced degrees are in great demand for outside consulting, which is usually permitted in recognition of circumstances where an individual's main employment provides low pay and slow advancement in academic rank or civil service grade. This same pattern is true for Filipinos trained with other project support, 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 1940s, this has been a relatively small number of individuals from which to choose. 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 MS programs in aquaculture have become operational, there should be less need to seek foreign assistance for training (or commensurate level research) up to that level. Support for PhD level training remains an important problem.

We do not know of any studies which have compared different types of aquaculture training programs. Our analysis shows that completion of an advanced academic degree has significantly effected 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 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. A drawback has been that is 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/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 certainly be a burden upon government agencies to replace equipment as it wears out.

Impact of donor assistance on capital development

Capital development expenses for most aquaculture projects have been a domestic counterpart contribution. With the exception of the facilities at SEAFDEC, most of the building cost have been modest, in keeping with the character of the surrounding public structures. Project construction has been slow, often more than a year behind, and not always of good design. Existing research facilities appear to be 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 aquaculture site and the UPV new facilities remain uncompleted.

CONSTRAINTS ON AND OPPORTUNITIES FOR CONTINUED AQUACULTURAL DEVELOPMENT

Aquaculture is a major factor in the well being of the Philippines, contributing 0.5% of the GNP, 5% of foods of animal origin, and approximately 200,000 jobs. Since the early 1970s the Philippines has been a pace-setter for aquacultural development. Although levels of aquacultural technology are not high, they are successful in the prevailing conditions. In terms of the model we used to describe aquacultural development, the Philippines has advanced from Stage 3 to Stage 5 in the past decade. Furthermore, we conclude that the potential for continued growth is among the highest when all countries are considered. Constraints on and opportunities for continued aquacultural development are summarized in the following paragraphs where we describe technical, social, economic, institutional, environmental and 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 conditions and similar physical factors are constraints in some locations. Research on these and other problems lessens their effects on aquacultural development potential.

Expansion of brackishwater ponds is constrained by the limited number of choice sites and by regulations on alteration of mangrove swamps. Expansion of pen and cage culture systems is constrained by the limited 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 aquacultures are intensified.

Milkfish and tilipia are the primary fishes being cultured, and they are well-suited to Philippine conditions. Other native and introduced species of finfishes, molluscs, crustaceans and seaweeds have varying potentials for culture. Some carp, prticularly the grass carp, appear most promising. Attempts are being made to culture bullfrogs, channel catfish, eels, macrobrachium shrimp and other species whose potential is likely to remain low given competition to raise other species of known value and successful culture.

Nutrient inputs of organic and inorganic fertilizers and feedstuffs, especially ones high in nitrogen or protein are constraints to future aquacultural development because their availability in country is limited and the cost of importation is high. Intensive feeding levels (level 5 and above) are presently not feasible because of these constraints.

Philippine producers have the experience, knowledge and capability to practice intensive fertilization (level 3) and extensive feeding (level 4) in brackishwater and freshwater ponds. We recommend intensification rather than extensification 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.

Intergrated 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 aquaculture combinations, appear to have high potential throughout the Philippines.

Social factors

Producer attitudes, knowledge and skills about aquaculture are positive. Not only do they perceive the need for change, but they also are actively

pursuing new technology from internal and external sources, doing trial-and-error research, and sharing production information. In aquaculture, as in all industry, some entrepreneurs may have taken risks not easily justified by known production potentials; 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 aquaculture systems; opportunities are most attractive for inland land holders such as rice farmers. The proposal by KKK for aquacultural development to be done by community-based groups rather than by individual owners has interesting but as yet unpredictable possibilities.

Milkfish production 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 cultures in lakes and mollusc and seaweed culture facilities in estuarine and marine environments face a potential constraint from competition for water resource use and conversion of public resources to private resources. Land reform for fishpond and other aquaculture operations, if seriously considered, must be done with a great deal of care, considering that allocation of resources is likely to be strongly influenced by those individuals who are wealthy and politically powerful.

Economic factors

The elasticity of demand for presently produced aquacultural foods appears to be very good - at 0.22 and higher. This will likely improve as capture fishery production levels off or declines. Domestic markets are

expected to absorb all non-luxury aquaculture 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 to producers are high capitalization required coupled with the inaccessability and high cost of credit. The generally low availibiltiy and poor access to nutrient inputs is a further constraint.

Participation by poor landless people in commercial aquaculture as owners or primary beneficiaries seems unlikely because they lack relatively large production areas required for economic viability, capital and access to credit; have questionable managerial ability, and low risk tolerance. Rice farmers would 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 commerical production with the potential for expansion into commercial level operations.

Infrastructure, especially the availability of ice and transportation to and from supplies and markets, 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. Some disregard repayment obligations while others may use loans for other than stated 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 PhD-level graduate program is desperately needed if quality manpower at all levels is to be produced, and if scientific research and graduate level academic programs are to survive. The PhD program is essential, but it must be accompanied by more effective means of keeping highly trained manpower productively employed in the university system than now exist.

Research facilities are more than adequate and physical plants are probably overbuilt for the next decade. Budgets and qualified research personnel are presently inadequate to maintain and operate the research facilities already built. Budgets already strained are not likely to increase commensurately with the new facilities under construction.

Research programs are fragmented, without clear direction. It appears that some scientists are pursuing easy solutions and avoiding the tough research problems. Evidence is strong that time and energies of senior research personnel are spent in the following order: a) pursuing consultancies and other non-research honoraria, b) satisfying administrative responsibilites, c) teaching, and finally, d) conducting research. Social and economic research needs to be coordinated and teamed with the technological research.

Academic education facilities and programs are minimally adequate for MS-level training. However, accrediation of BS and especially MS programs are in jeopardy because there are limited numbers of qualified professors and there is the high probability of losing the few qualified teachers who remain.

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

1. to decentralize extension responsibilities to the regional offices,

2. to reorganize and reprogram extension functions and upgrade job qualifications,

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

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

We are unable to speculate on the long range impacts of the high proportion of women in current programs. Women comprise 60 to 70% of the trained manpower, and the majority of current MS students are female.

Administratively the GRP has, for the most part, done an admirable job in supporting aquacultural development. All needed organizations are in place with broad, reasonably thorough, programs. However, goals, policies and programs are organized horizontally rather than vertically which tends toward a strong bureaucracy rather than strong development services. There is a tendency for budgets to be salary heavy at the expense of operations support. Budget allocations will have to reflect the needs associated with recent construction, and perhaps should be balanced so that extension services receive more than they are currently allocated, and SEAFDEC less. Proliferation of agencies and institutions has grossly diluted resources, created duplication and confusion, and hampered efficiency and effectiveness of services. For example, SEAFDEC is recognized as a costly duplication of major functions mandated and implemented in the university and BFAR programs.

Regulations and bureaucratic procedures relative to aquaculture appear reasonable and fair; however, enforcement of laws are generally weak and paper

work for permits and loans is extremely slow. A means of requiring accountability of performance of institutions and personnel at all levels within institutions, especially BFAR, is needed. Typical of most governments, there seems to be an inability of authorities to deal with weak performance by agencies, divisions, offices and individuals.

The use of some BFAR stations and hatcheries is suspect. 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. A study is needed to determine the needs of hatcheries and how best to meet those needs. BFAR hatcheries are not productive and some fry distribution-stocking programs are of questionable use.

The Philippine Federation of Fishpond Producers recognizes the need for technology development and diffusion, 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 service involvement. They claim 12 regional and 37 provincial chapters with about 30,000 members. 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.

People involved in aquacultural development in the Philippines in both private and public sectors need to begin to think of Research and Development using internal as well as external sources of funding. Aquacultural development has reached the stage where manpower, technology, statistics and other needs of continued research and development can and should be done internally rather than externally.

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 from fishpond development could be the most beneficial service the GRP can provide to municipal fishermen at this time, assuming that the swamps serve an important link in production of fish sought by capture fishermen. Allowing poorly developed or otherwise non-productive fishponds to revert to mangrove forest may be the best use of those areas.

Development of freshwater ponds inland is not considered a significant negative impact on the environment, while the impact of pens and cages on lake environments is not understood. Aside from the adverse effects cultured species may have, eutrophication from feed additives may be the next most likely negative impact of pen and cage cultures.

In spite of strong encouragement for the GRP to establish hatcheries for milkfish fry, we would recommend against that action. The technology is not yet available nor are the fry 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 tilapia has been economically beneficial and, therefore, may be judged worth the environmental cost, others, such as Zill's tilapia and Thai catfish (Thai hito), are likely to be judged not worth the cost. We would suggest that the GRP needs to tighten its control on imports and distribution of exotic species. At the same time, the

GRP needs to control potentially toxic substances in pond systems. Endrin and some other pesticides still in use in fishponds are ecologically destructive. Domestic pollution in mollusc production areas enhances production but limits markets because of the high risk of disease.

Political and other 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% of the population, have been identified as among the poorest sector of the Philippine economy. This fact has raised concerns about ways in which income and standard of living might be improved for this group. The resources upon which these artisanal fishermen depend may now be overfished, and in any case, offer little potential for increased catch. If fishing pressure is not reduced, it is likely that overall catch (and certainly catch per unit effort) will decline in the near future resulting in even lower incomes, fewer and more expensive fish contributing to the national food budget, and less employment for an already overcrowded industry. Faced with these prospects, some people have suggested that aquaculture could be developed as an alternative source of livelihood and employment for at least 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 ways to deal with small-scale fishermen have been the topic of several international meetings: the 1975 gathering in Costa Rica (Estes 1976), the 1980 Indo-Pacific Fishery Commission Symposium in Japan (IPFC 1980) and the November 1981 workshop-seminar in Manila sponsored by the FAO/UNDP South China Sea Fisheries Development and Coordinating Programme (FAO 1981). Several papers are available discussing the potentials and socio-economic considerations for aquaculture in dealing with these small-scale fishermen (see attached bibliography). The characteristics of small-scale fisheries in the Philippines have already been reviewed in Smith et al. (1980). Here we do not attempt to redescribe information that is already available, but rather attempt to reason and draw some conclusions based on what has already been described and our own interpretations.

Potential small-scale aquacultures

Brackishwater fish culture carried out in coastal ponds is by far the best established aquaculture in the Philippines and is done in areas closely associated with artisanal fishing activites. The yields from existing ponds are generally below their potential and efforts to increase the intensity of culture and respective yields make sense. Such intensification will necessarily increase the labor demands for operation of the ponds and it is reasonable to expect some if not most of this labor will be drawn from people who would otherwise be employed in subsistence fishing. It is difficult to guess just how much employment might result from intensification, but if we assume an additional man for every 10 ha and a total of 50,000 ha brought into such management, that would mean new work for some 5,000 people.

We have also concluded that the desirability of expanding into new areas for brackishwater pond development is not good because of the need to preserve

and conserve what now appear to be limited coastal mangrove forests. The mangrove areas already sustain heavy use by coastal residents and have important ecological functions that should not be lost. The development of expansive areas of new brackishwater fishponds to produce employment should consequently be viewed with skepticism. Strong 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 some sort of central association. Such schemes have been attempted in Indonesia and Taiwan without much success in achieving the social objectives of the development. Similar proposals have been made for the Philippines, and such developments were introduced in Zamboanga and Mindoro. We have mixed opinions as to the chance of economic or social success; some of the authors of this report believe the potential for estates is promising to the point that the concept deserves to be tested. Others are less optimistic in part because of the results of a large workshop convened in Los Banos about 1975 to discuss the feasibility of fishery estates. The general conclusion from this workshop was that the development costs were so high and the rate of return so low that it did not appear to be a good development investment. There also was a very high cost per beneficiary (a multimillion peso case example of 500-ha would only directly benefit about 100 families at a development cost in excess of $20,000/family). If the fishery estate mode must be tested for social or whatever reasons, we would suggest that it be limited to a pilot scale (say 50 ha) until more experience is available upon which to make judgements.

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 not everywhere abundant and a fair amount of capital and risk are involved. Smith and Pestano-Smith (1980) reviewed the recent history of seaweed farming in the Philippines, and SEAFDEC (Tortell and Yap 1976) and FAO (1981) have done recent work assessing the opportunities for mollusc culture. Oyster and mussel culture have potential but will need facilities for sanitary control if market expansion is considered.

The booming pen and cage fish culture activities in Laguna de Bay have attracted much attention and led to an ADB-financed Laguna Lake Development Authority project to assist lake fishermen go into milkfish or tilapia cage or pen culture in a reserved belt area of the lake. Mixed reports about the success of fish culture in Laguna de Bay enclosures have been received, so it will be very interesting to see what fish production and loan repayment history develops as a result of this project. 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 have enough food to sustain fish growth in densely stocked enclosures. The use of artificial feeds, even were they available, appears to be prohibitively expensive for use in fish culture in the Philippines at this time. Those wishing to venture into pen/cage cultures should recognize that such cultures are high-risk and may have high capital requirements if practiced on a large-scale or intensively. The best sites in Laguna de Bay are already taken. Average yields from pens placed at random in the lake will not be greater than from an equal area of open lake.

Social issues

Bakar and Arshad (1980) and Pollnac (1982) suggest that many artisanal fishermen would resist shifting to agriculture (or aquaculture) because it was not suited to their basic temperment or traditions. This would certainly be true of some Filipino fishermen, although results reported by Smith et al. (1980) indicate that many Filipino fishermen would be happy to take up farming if they but had access to land or a paying job in agriculture. There are also indications that some fishpond caretakers and laborers go into fishing occasionally to augment their income from aquaculture. Many Filipinos are fishing simply because they have little other employment opportunity in life. The population pressure has forced them to the water's edge. This also means they have little opportunity to move inland to take up freshwater aquaculture. Another feature is that the demand for space even at the water's edge is also great. Evidence suggests that where significant numbers of subsistence fishermen are given other employment new people quickly enter the fishery to take the space that was opened. This means the prospects for taking pressure off the capture fishery resources are not good.

Low income people also present some handicaps in terms of how they may fare in new business undertakings. By background they are little educated and with poor communications skills. They also have relatively little managerial or financial experience. Family and political influences are negligible. All this means that subsistence fishermen brought into aquaculture would be vulnerable to manipulation and exploitation by outside forces and at a competitive disadvantage with other operators.

A whole set of issues also arises when open access public resources are subject to private monopolization such 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. Building more ponds in the communal coastal mangrove forests, placing cages in public lakes and rivers, setting mollusc attachment structures in bays and rich estuaries, and fixing nets for seaweed farming to the seabed are all examples of potential use, ownership and allocation conflicts. Who gets the best locations, how much at what cost, how will competition be regulated, for how long, and similar questions are delicate issues that need to be resolved in advance. If broad social benefits are desired then regulations would need to be made and enforced to divide public resources used for aquaculture into small (not necessarily the most efficient) units.

During discussions, team members expressed mixed opinions regarding the constraints and opportunities for aquaculture as an employment alternative for small-scale fishermen. We have obviously presented more constraints than opportunities. Although we all stongly agree with the unfortunate plight and need to help the large number of low-income fishermen in the Philippines, we do not foresee that development of aquaculture represents much hope for providing an alternative livelihood to these people or relieving pressure on the municipal fishery resource. It appears that the growth of aquaculture in the coastal areas will be limited because of limited sites for new ponds. We do expect an intensified production effort in existing ponds that should slightly increase labor demand in existing pond areas. Otherwise, the need to preserve mangrove swamps, the economic factors, market demand, and social ownership issues will likely limit development of coastal aquacultural systems for small operators. Access to inland aquaculture opportunities will likely go to those already on the land rather than to people translocating inland.

We must wait for results of the trial fishpond estates in Zamboanga and Mindoro, but the costs and benefits to develop coastal aquaculture estates are not likely favorable compared to other development investment alternatives. Last of all, even providing other employment will not save the fishery; the use pressure is just too great to expect any significant impact on the fishery from diversionary aquaculture schemes. We recommend research rather than development projects in the GRP's pursuance of opportunities in aquaculture for municipal fishermen. If development projects must be implemented we strongly recommmend a multi-disciplinary design approach that would address all the social and economic as well as technical elements of implication.

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Footnote

[1] The regions in the Philippines were numbered from I - XI until 1979; after that time, I - XII. In this report, especially tables 9 and 10, the following assignment of Provinces to Regions are 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., Mondoro 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 Sure, Bukidnon, Lanao del N., Lanao del Sur, Misamis occ., Misamis Or., Surigao del N., Surigao del S.
Region XI: Maguindanao, S. Cotabato, Davao del Norte, Davao del sur, Davao Oriental

Appendix A

Foreign Assistance Financing

The procedure of obtaining foreign financial assistance for certain development projects differs with the source of assistance.

FAO/UN Development Programme

1. Preparation of a Five-Year Country Program which contains the development thrusts of the government, the specific projects which translate the government goals.
2. Implementation of country program is carried out after NEDA and UNDP have agreed on it. Preparation of more detailed project study will then be made to determine exactly the cost entailed by each project.
3. Financial assistance is extended upon approval of country porgram and implementation of projects.

US Agency for International Development

1. Until 1979, specific project proposals were submitted to USAID for financing.
2. Starting 1980, a Country Development Strategy Statement came to be formulated and adopted as basis for USAID financial assistance to the country. The statement is revised yearly in tune to the country's development goals and objectives.
3. Projects proposed should be in tune with the Statement's goals and objectives and are screened by USAID and Philippine government.
4. Preparation of loan proposal.
5. Submission and negotiation of loan.

Bilateral Sources (German, Japanese, etc.)

1. Project identification through an Identification Mission sent by respective funding countries.
2. A shopping list of projects is made.
3. Project selection goes through a series of channels before approval.

World Bank/ Asian Development Bank

1. Project identification by and Identification Mission send by the funding agency together with NEDA, Ministry of Foreign Affairs and the ministry/agency concerned.
2. Project preparation including the preparation of loans agreement by local agency concerned with the assistance of NEDA.
3. Submission of project to funding agency.
4. Appraisal of project proposal by a mission from funding agency.
5. Loan negotiation and signature of loan.
6. Implementation of project.

Appendix B

The Integrated Fisheries Development Plan

Presidential Decree No. 704 (Fisheries Decree of 1975) recognized the urgent need to revise and consolidate all laws and decrees affecting fishing and fisheries to make them more responsive to the needs of the fishing industry.

Declaration of Policy (Policy of the State)

- to accelerate and pormote the integrated development of the fishery industry.
- to keep the fishery resources of the country in optimum productive condition through proper conservation and protection.
- to promote and encourage the organization of, provide assistance to, and help integrate the activities of persons, associations, cooperatives and corporations engaged in the industry so that the nation may achieve the maximum economic utilization of its fishery resources.
- to consider the fishery industry as a preferred area of investment.
- to encourage and promote the exportation of fish and fishery/aquatic products to enable the fishery industry to contribute to the development and growth of the national economy.
- to allow the private sector the privilege to utilize to utilize fishery resources and to make it participate in the conservation and development of the fishery resources of the country.

Presidential Decree No. 704 also-

- defined the jurisdcition of the Bureau of Fisheries and Aquatic Resources (BFAR).
- created the Fishery Industry Development Council (FIDC).
- set guidelines on the utilization and exploitation of fishery/aquatic resources.

Presidential Decree No. 1015 (Amendments on PD 704)

- introduced amendments on commerical fishing boat license and on travel fishing in waters 7 fathoms deep or less.

Presidential Decree No. 1058 (Amendment of PD704)

- increased the penalities for certain forms of illegal fishing, dealing in illegally caught fish or fishery/aquatic products, and for other purposes.

Presidential Decree No. 977

- created the Philippine Fish Marketing Authority, defined its functions an dpowers, and for other purposes.

Executive Order No. 772 (Amendments to PD977)

- amended the Philippine Fish Marketing Authority.
- created the Philippine Fisheries Development Authority.

Appendix C

Major Fishery Agencies

A. Bureau of Fisheries and Aquatic Resources (BFAR)

Main Responsibility: Implementing arm for all policies and programs on fish production and conservation.

Existing Activities:

i) Conservation and law enforcement - Appreshension of violations of Fisheries Laws; Modification of existing fishery rules and regulation; Information dissemination on conservation through the Regional Fisheries Training Center (RFTC).

ii) Licensing - fishing boat licensing; mapping and cartography; administration of Fishpond Lease Permit.

iii) Utilization -- Handling; Processing; Production Development; Inspection and Quality Control.

iv) Propagation - Freshwater and Brackishwater Development; Water Pollution Control; Development of Communal Fisheries; Development of Sea Farming.

v) Research - Aquaculture Development; Strengthening Fishing Technology Research; Fisheries Biology, Limnology.

vi) Engineering - Engineering Research; Development of Infrastructure; Construction of Vitas Repair Shop and Warehouse; Refrigeration.

vii) Extension - Aquaculture Extension; Fish Processing Extension; Marine Fisheries Extension; Evaluation.

Proposed Activities

i) Research - Marine research primarily along the areas of resource assessment and monitoring of the marine environments; Non-marine research primarily in verification studies and/or identification of areas for research work to be endorsed to other appropriate institutions.

ii) Conservation and Law Enforcement -- Apprehension and prevention of violations of fishery laws.

iii) Production:

a) Extension - Strengthen RFTC's and Demonstration Center; Improvement of ice plant and cold storage operations;

b) Licensing - De limiting the geographic coverage of licenses and limiting the volume of fish catch to promote both production and conservation.

iv) Statistics Generation - Establishment of organizational linkages with NEDA/NCSO; Establishment of assets to compute facilities for data storage and processing; Provision of communication system between statistics head office and natiowide network for data collection.

B. Fishery Industry Development Council (FIDC)

Main Responsibility: Formulation and review of policy guidelines for the management and utilization of fishery and aquatic resources and for the creation of a favorable investment climate for the development of a fishery industry.

Existing Activities:

i) Designing and packaging of fishery development programs for both local and foreign funding.
ii) Development and implementation of action plans and support programs and studies, in coordination with other agencies.
iii) Initiation of infrastructure projects, research and extension programs and credit facilities.

Proposed Activities:

i) Preparation and continour updating of the Integrated Fishery Development Plan.
ii) Initiation, development and implementation of development programs in coordination with other agencies.
iii) Close monitoring of program/project implementation especially those turned over to other fishery agencies.
iv) Evaluation of project/program implementation.
v) Continous review of fishery policies especially with regards to government participation/intervention in the industry.
vi) Facilitate inter-agency coordination through organization of a program evaluation and policy research group who would evaluate and reformulate policies and programs to make them relevant to existing conditions.

C. Philippine Fish Development Authority (PFDA)

Main Responsibility: Insure the availability of a steady supply of fish and aquatic products for the consumers as well as the marketability of these commodities.

Existing Activities:

i) Management of Navotas Fish Port and Other Fishpond Complexes - harbor operators, port trading activites, monitoring of prices and volume unloaded, billing and collection of fees.
ii) Participation in the planning of ports development.
iii) Undertakes the procurement and distribution of fish products on limited and experimental basis. In this connection, the Authority could acquire, maintain, operate, purchase, lease of dispose of equipment such as vessels, fishing gears, refrigerated truck, van, ice and cold storage plants, etc.
iv) Collection and dissemination of price statistics and volume of fish landed in Navotas, other major ports in selected markets.
v) Assessment and collection of reasonable fees, tolls, charges, rentals for the use, lease or sale of property, equipment, facilities and services in order to raise revenues for the Authority.
vi) Formulate and implement rules on the conduct of business activites inside the fishing port complexes.
vii) Organization of retailer's cooperatives in Metro Manila and provision of referral services for importers and exporters.

Proposed Activities:

i) Management of fish ports - formulation and implementation of policies on the conduct of commercial activities, e.g., fish port landing, training and maintenance; identification of feasible fish port sites and the specification and development of the various infrastructure and services requirements of these ports.

ii) Marketing system re earch - output of which are essential inputs in the formulation of policies related to regulation and licensing.

iii) Market information monitoring.

iv) Other support activities - cooperate with MNR and other fishery agencies in developing alternative schemes of government intervention to achieve price and supply stabilization and the planning of the machiery for its implementation.

Manpower Resources and Facilities

1. Bureau of Fisheries and Aquatic Resources (BFAR)

Personnel Complement (1980):

Technical	1235
Non-Technical	1168
Casual	752
Total	3155

Facilities (1978):

Freshwater Fishfarms	25	farms
Brackishwater Fishfarms	18	"
Shellfish farms	13	"
Marine farms	2	"
Ice Plant and Cold Storage	16	(constructed)
Fishing Vessel for Ice Plant and Cold Storage	17	(under construction)
Fisherman Vessel for Training and Research	8	

Fisherman Training Center complete with classroom, library, trainor's quarter and research equipments.

2. Fishery Industry Development Council (FIDC)

Personnel Complement:

Office of the Executive Director	7
Administrative Staff	18
Technical Staff	4
Total	69

3. Philippine Fish Marketing Authority

Personnel Complement:

Market Rationalization Program	5
Management Systems Development Staff	5
Planning and Development Dept.	32
Operations Department	6
Navotas Fish Port & Fish Market	7
Administrative Department	3
Financial Management Dept.	3
Total	61

Facilities & Asset:

Administrative Building	1
Market Halls	4
Civil Works: quay walls, breakwater piers, transport & other equipment	18

Appendix D

Research Objectives for the 1980's

RESEARCH OBJECTIVES

Research programs for fisheries should be geared towards effective management and development of the country's fisheries resources. Hence, research thrusts for the coming yers should not lose sight of the:

- improvement of management measure for rational exploitation of the country's fishery resources
- upgrading of technology in marine capture and culture fisheries and post-harvest handling
- improvement of socio-economic status of small fishermen

Research studies for the marine fisheries aquaculture and post-harvest handling should focus on the following goals:

1. MARINE FISHERIES
   - build-up of resource information base for rational management of fishery resources
   - exploration of under-exploited fisheries and areas
   - technology development
2. AQUACULTURE
   - technology development to increase ponds, pens and cages production per unit area
   - increase availability of fry and seedlings nationwide throughout the year
   - development of seafarming
   - development of argo-fishery systems
   - management and regulation of inland water utilization
3. POST-HARVEST
   - development of technology
   - establish quality standard for fish and fishery products
4. ECONOMICS
   - identify financially viable technology
   - analyze impact of developmental projects
   - improvement of marketing system

RESEARCH PRIORITY AREAS

For rational management and development of the country's fishery resources, the priority research areas listed in the PCARR National Fisheries Commodities Research Program are basically covered in the research areas identified in the Integrated Fisheries Development Plan.

RESEARCH INSTITUTIONS

The following are the major research institutions engaged in fisheries research:

1. UPCF-Institute of Fisheries Development and Research (IFDR)
   a) Research Area:
      - Stock Assessment of Pelagic and Demersal Speices
      - Test Fishing
      - Culture and Breeding of Exotic Fishes
      - Small-Scale Culture of Tilapia
      - Small-Scale Fish Processing
   b) Facilities:
      - two research vessels
      - 200 ton Albacore
      - fish finding equipment
      - hydroacoustics

c) Personnel: 32
d) Budget: P1.08 Million
Grant: P2.5 Million

3. Bureau of Fisheries and Aquatic Resources (BFAR)
Research Division
a) Research Area:
- Test Fishing
- Stock Assessment
- Tuna Stock Assessment
- Fishery Oceanographic Survye
- Biological Studies of Pelagic and Demersal Fish Species
- Ecological Studies of Inland Waters

b) Facilities:
- four research vessels
- scientific sounders
- research stations

c) Personnel:
d) Budget: P7 Million

4. UP Marine Sciences Center
a) Research Area:
- Coral Ecology
- Invertebrate Biology
- Seaweed Processing and Biology
- Mangrove Ecology

b) Facilities:
- Seaweed Laboratory
- Greenhouse
- Coral Laboratory

c) UP-Brackishwater Aquaculture Center
1) Research Area:
- Brackishwater Aquaculture (milkfish, tilapia, mullet, sea bass)
- Fertilization of Ponds
- Sol and Water Management
- Fry and Fingerling Survival
- Feed Formulation
- Agro-aqua Systems

2) Facilities:
- 22.5 has. research and demonstration ponds
- 10 has. demonstration farm
- Research Laboratories

3) Personnel: 80
4) Budget: P800,000
Grants: P855,027

5. CLSU-Freshwater Aquaculture Center
a) Research Areas
- Freshwater Pond Culture
- Broodstock Development
- Feed Development
- Agro-aqua System
- Invertebrate Culture
- Pond Layout and Construction

b) Facilities:
- 11.5 has. water surface
- 20 has. land area
- Research Laboratory
- Tanks

c) Personnel: 30

d) Budget: P250,000
- Grants P11,000,000
- Foreign Grants P3,000,000

6. SEAFDEC-Aquaculture Department

a) Research Areas:
- Marine, Brackishwater and Freshwater Aquaculture
- Fry Survival Studies
- Broodstock Development
- Seed Production
- Seafarming (Oyster, Mussel, Seaweed)
- Nutrition and Feed Development
- Aquaculture Economics
- Aquaculture Engineering

b) Facilities:
- SEAFDEC Complex
- Research Demonstration
- Ponds
- Research Laboratories

c) Personnel: 650

d) Budget: P47 Million

Appendix E

Areas of Concern of Philippine Research Institutions

Research Priority Areas	Major Agencies Involved
A. Marine	
1. Management of Resouces	
a) Stock Assessment	
- Improvement and Expansion of Present Statistical System	BFAR, UPCF-IFDR, SCSP, ICLARM
- Monitoring of Changes in Fish Stock Abundance	BFAR, SCSP
- Estimation of Potential of Marine Resource Stocks	BFAR, UPCF-IFDR, ICLARM
- Fry Resource Assessment	
— Milkfish	BFAR
— Other Fishes	BFAR
b) Biological Studies of Commercially Important Species	
- Collection of Information	UPMSC, BFAR, UPCF-IFDR
on Feeding Habit	
- Collection of Information on Fish Age	UPMSC, BFAR, UPCF-IFDR
- Life History of Fishery Resources	UPMSC, BFAR, UPCF-IFDR
- Survey to Collect Data on Fish Mortality	UPMSC, BFAR, UPCF-IFDR
c) Fishing Surveys	
- Exploratory Surveys of Non-Traditional Grounds	BFAR, UPCF-IFDR
- Research Monitoring Surveys	BFAR, UPCF-IFDR, SCSP
d) Environmental Studies	
- Oceanographic Surveys of the Country's Fishing Grounds	BFAR, UPCF-IFDR
- Pollution Studies	UPMSC, NPCC
- Studies of Impact of Degradation of Mangrove Swamps on Fishery Resources	BFAR, UPMSC
e) Vessel and Gear Studies	
- Mesh Size Selectivity of Purse Seine, Ringnet, Trawl, etc.	BFAR, UPCF-IFDR, ICLARM
- Determination of Suitable Size and Number of Type of Vessels	BFAR, UPCF-IFDR, SCSP, ICLARM
- Studies on the Limitation of Juvenile Capture of Tuna Sardines, Chub Mackerel,	BFAR, UPCF-IFDR

Research Priority Areas	Major Agencies Involved
Roundscads and other Stocks whose Juveniles are Caught Extensively	
2. Technology Development	
a) Gear Technology for Exploited Stocks	
- Development of Passive Gears for Hard Grounds	BFAR, SCSP, ICLARM
- Development of Selective Gears for Catching Exploited Pelagic Stocks	BFAR, SCSP, ICLARM
b) Fishing Craft Technology	
- Development of Municipal Vessels Using Materials Other than Wood	BFAR, SCSP, ICLARM
- Development of MOre Efficient Vessels	BFAR, SCSP, ICLARM
c) Development of Fuel Saving Gears/Vessels	BFAR, SCSP, ICLARM
B. Aquaculture	
1. Development of Fisheries	
a) Pond Culture	
i) Milkfish	
- Fry availability	
— Fry survival during catching, handling, transport and storage	BAC, SEAFDEC
— Articicial breeding	BAC, SEAFDEC
— Location of new fry grounds	BAC, SEAFDEC
- Fingerling production	
- Improvement of Culture Technique	
— Pond layout and construction	BAC, SEAFDEC
— Soil and water management	BAC, SEAFDEC
— Stock manipulation	BAC, SEAFDEC
— Fertilization	BAC, SEAFDEC
— Feed formulation	BAC, SEAFDEC
ii) Tilapia	
- Hatchery and Nursery Production	BAC, SEAFDEC, CLSU
- Production of High Quality Fingerlings	BAC, SEAFDEC, CLSU
- Control of Fish Reproduction	BAC, SEAFDEC, CLSU
- Tilapia Culture in Brackishwater Pond	BAC
- Pond Construction	BAC, CLSU
iii) Prawns	
- Fry availability	
— Location of new fry grounds	BAC, SEAFDEC
-- Broodstock development	BAC, SEAFDEC

Research Priority Areas	Major Agencies Involved
— Larvae rearing and feeding	BAC, SEAFDEC
-- Fry survival during catching, handling, transport and storage	BAC, SEAFDEC
— Hatchery system development	BAC SEAFDEC
— Diseases and pest control	BAC, SEAFDEC
- Improvement of Culture Techniques	
— Polyculture techniques	BAC, SEAFDEC
— Supplemental feeding which includes development of artifical feeds	BAC, SEAFDEC
— Soil and water management	BAC, SEAFDEC
— Pond layout and construction	BAC, SEAFDEC
iv) Other Potential Species for Culture	
- Screening of potential Species Including Aquarium Fishes	BAC, BFAR, CLSU, FAC
- Development of culture techniques	BFAR, BAC, CLSU, FAC
b) Fishpen and Cages	
i) Cage and pen designs	BAC, SEAFDEC, CLSU
ii) Feeds and feeding studies	BFAR, SEAFDEC, CLSU
iii) Determination of potential species for pen and cage culture and development of new techniques for their culture	BFAR, SEAFDEC, CLSU
c) Seafarming	
i) Development/improvement of culture techniques for shellfishes and seaweeds	BFAR, SEAFDEC, BAC
ii) Increase in seedling availability	BFAR, SEAFDEC, BAC
iii) Determination of potential species for seafarming and development of new techniques for their culture	BFAR, SEAFDEC, BAC
d) Development of Other Culture Techniques	
i) Agriculture-aquaculture system such as rice-fish, pig-fish and chicken-fish culture	BFAR, SEAFDEC
C. Inland Waters	
1. Management of the Resources	
a) Ecological Studies	
i) Limnological studies	BFAR, CLSU
ii) Productivity studies	BFAR, CLSU

Research Priority Areas	Major Agencies Involved
b) Stock assessment and biology	BFAR
2. Development of the Fisheries	
a) Improvement/development of fishing gears	BFAR
b) Assessment of stocking of Inland waters	BFAR
D. Post Harvest	
1. Development/Improvement of Handling and Processing	
a) Improvement of present handling and/or chilling techniques	BFAR, UPCF-IFDR, SEAFDEC, FTI
b) Establishment of quality standards	BFAR, UPCF-IFDER, FTI
c) Development of new products	IFDR, BFAR, FTI
d) Refrigeration and cold storage	BFAR, FTI
e) By-product utilization	UP-MSC, UPCF-IFDR, FTI
E. Sociological and Economic Studies	
1. Improvement of Marketing System	FIDC, PFMA, BAEcon
2. Cost-Return Studies	FIDC, BAEcon, TBAC
3. Packaging Credit System	FIDC, TBAC
4. Demand Studies	FIDC
5. Socio-Economic/Impace Studies	FIDC, SEAFDEC, BAEcon ICLARM
F. Review and Analysis of Existing Rules and Regulations	
1. Review and Evaluation of Existing Fishery Regulations	FIDC
2. Review of Existing Licensing Schemes	FIDC
3. Policy Guidelines for Mariculture Industries	FIDC
4. Review of Municipal Regulations	FIDC

Appendix F

Expanded Fish Production Program

Locations	:	Nationwide
Implementing Agency	:	Bureau of Fisheries and Aquatic Resources
Objectives	:	The program aims to: 1) achieve self-sufficiency in fish; 2) promote import substitution, and 3) increase exportation of fishing products.
Project Description	:	The program consists of: 1) development projects on inland and aquatic fisheires; 2) commerical fisheries; 3) minicipal fisheries; 4) fish utilization; and 5) fish conservationa and management.
Cost	:	Total project cost for CY 1981 is P107.8 million.
Project Duration	:	This is a continuing program.
Status	:	1. Inland Fisheries - 22 million fingerlings were produced in BFAR farms; 15 million were dispersed; 10,756 hectares were improved by extension workers. 2. Commerical Fisheries - 186 commercial fishing vessels were convered by extension workers under deep-sea fishing operation. 3. Municipal Fisheries - 5,637 bancas were imporved and motorized by extension workers. 4. Blue Revolution - 1,535 municipal fishermen were trained by BFAR specialists; 51 seafarming projects were established and maintained. 5. Biyayang Dagat - P46 million loans were released as STDs to 3.600 fishermen.

Appendix G

Profiles of On-Going Projects Under the Expanded Fish Production Program
(As of 30 June 1981)

Region	Location
Region I	- Abra, Benguet, Ilocos Norte, Ilocos Sur, La Union, Pangasinan
Region II	- Cagayan, Ifugao, Isabela
Region III	- Bataan, Bulacan, Nueva Ecija, Pampanga, Tarlac, Zambales
Region IV	- Batangas, Cavite, Marinduque, Mindoro, Quezon, Romblon, Palawan
Region V	- Albay, Camairnes Norte, Camarines Sur, Catanduanes, Masbate, Sorsogon
Region VI	- Aklan, Antique, Capiz, Iloilo, Negros Occidental
Region VII	- Bohol, Cebu, Negros Oriental, SIquijor
Region VIII	- Northern Leyte, Eastern Samar, Western Samar, Northern Samar
Region IX	- Basilan, SUlu, Tawi-Tawi, Zamboanga del Norte, Zamboanga City
Region X	- Agusan del Norte, Agusan del Sur, Bukidnon, Camiguin, Misamis Oriental, Misamis Occidental, Surigao del Norte
Region XI	- Davao City, Davao del Norte, South Cotabato
Region XII	- Lanao del Norte, Lanao del Sur, Maguindanao, Cotrabato, Sultan Kudarat

Source: Profiles of Major programs and Projects by Region Project Monitoring Staff
Programs and Projects Office
National Economic and Development Authority
September 1981, 388 pages.

DETAILS OF EXPANDED F'SH PRODUCTION PROGRAM

	Target	Actual	%	Expenditure Amount (P000)
Region I				
Inland Fisheries				467.45
Fingerlings produced	12.43M	7.40M	59	
Fingerlings dispersed	5.65M	5.41M	96	
Commerical Fisheries				
Commerical fishing vessels	6	11	183	
Municipal Fisheries				
Bancas imporved and motorized	294	239	81	
Blue Revolution				514.70
Fishermen trained	N.T.	31	-	
Seafarming projects	N.T.	2	-	
Region II				
Inland Fisheries				244.84
Fingerlings produced	2.98M	1.49M	50	
Fingerlings dispersed	2.25M	1.33M	50	
Commerical Fisheries				
Commercial fishing vessels	8	9	120	
Municipal Fisheries				
Bancas improved and motorized	156	69	44	
Blue Revolution				
Fishermen trained	-	-	-	
Seafarming projects	N.T.	2	-	220.05
Region III				
Inland Fisheries				
Fingerlings produced	1.61M	0.28M	17	60.02
Fingerlings dispersed	2.36M	0.28M	12	
Commercial Fisheries				
Fishing vessels covered	4	-	-	
Municipal Fisheries				
Bancas improved and motorized	310	107	34	
Blue Revolution				335.32
Fishermen trained	-	-	-	
Seafarming projects	N.T.	5	-	
Region IV				
Inland Fisheries				N.A.
Fingerlings produced	6.81M	4.83M	71	
Fingerlings dispersed	9.81M	3.74M	38	
Commercial Fisheries				
Fishing vessels covered	26	31	119	
Municipal Fisheries				
Bancas improved and motorized	2,313	771	33	
Blue Revolution				N.A.
Fishermen trained	-	29	-	
Seafarming projects	-	7	-	

	Target	Actual	%	Expenditure Amount (P000)
Region V				
Inland Fisheries				249.31
Fingerlings produced	3.48M	4.62M	133	
Fingerlings dispersed	3.04M	1.57M	52	
Commercial Fisheries				
Fishing vessels covered	15	27	180	
Municipal Fisheries				
Bancas improved and motorized	726	627	86	
Blue Revolution				5 4.20
Fishermen trained	-	-	-	
Region VI				
Inland Fisheries				247.04
Fingerlings produced	1.52	.95M	62	
Fingerlings dispersed	1.70M	.68M	40	
Commercial Fisheries				
Fishing vessels covered	8	14	175	
Municipal Fisheries				
Bancas improved and motorized	1,468	875	59	
Blue Revolution				335.97
Fishermen trained	-	20	-	
Seafarming projects	-	2	-	
Region VII				
Inland Fisheries				156.36
Fingerlings produced	.56M	.23M	41	
Fingerlings dispersed	.30M	.12M	40	
Commercial Fisheries				
Fishing vessels covered	6	9	67	
Municipal Fisheries				
Bancas improved and motorized	617	802	130	
Blue Revolution				539.63
Fishermen trained	-	90	-	
Seafarming projects	N.T.	5	-	
Region VIII				
Inland Fisheries				72.85
Fingerlings produced	1.85M	1.04M	56	
Fingerlings dispersed	1.91M	.48M	25	
Commercial Fisheries				
Fishing vessels covered	2	1	50	
Municipal Fisheries				
Bancas improved and motorized	383	159	42	
Blue Revolution				365.01
Fishermen trained	-	-	-	
Seafarming projects	-	5	-	

	Target	Actual	%	Expenditure Amount (P000)
Region IX				
Inland Fisheries				42.77
Fingerlings produced	-	-	-	
Fingerlings dispersed	25,002	238,000	952	
Commercial Fisheries				
Fishing vessels covered	44	42	95	
Municipal Fisheries				
Bancas improved and motorized	708	861	122	
Blue Revolution				758.86
Fishermen trained	-	148	-	
Seafarming projects	-	4	-	
Region X				
Inland Fisheries				
Fingerlings produced	2.53M	.50M	20	N.A.
Fingerlings dispersed	5.06M	.51M	9	
Commercial Fisheries				
Fishing vessels covered	15	14	93	
Municipal Fisheries				
Bancas improved and motorized	563	510	90	
Region XI				
Inland Fisheries				61,479
Fingerlings produced	.74M	.49M	66	
Fingerlings dispersed	.59M	.14M	24	
Commercial Fisheries				
Fishing vessels covered	4	4	100	
Municipal Fisheries				
Bancas improved and motorized	300	232	77	
Blue Revolution				810,026
Fishermen trained	-	100		
Seafarming projects	-	1	-	
Region XII				
Inland Fisheries				152.88
Fingerlings produced	.98M	.27M	27	
Fingerlings dispersed	1.09M	.51M	46	
Commercial Fisheries				
Fishing vessels covered	3	-	-	
Municipal Fisheries				
Bancas improved and motorized	431	127	29	
Blue Revolution				388.52
Fishermen trained	-	83		
Seafarming projects	-	2	-	