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Rural Aquaculture in the Philippines

REGIONAL OFFICE FOR ASIA AND THE PACIFIC
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PREPARATION OF THIS DOCUMENT

This document, prepared under an author's contract by Mr. Wilfredo G. Yap, presents a review of rural aquaculture in the Philippines. The opinions expressed in this publication are those of the author's alone and do not imply the expression of any opinion whatsoever on the part of FAO.

ABSTRACT

As a follow-up of the publication on Rural Aquaculture: Overview and framework for country reviews - RAP Publication 1997/36, efforts have been made to review rural aquaculture in some of the major aquacultural countries in Asia and the Pacific Region. Rural Aquaculture in the Philippines is the first publication under this series, and it is expected that similar publications on other countries such as China, India, etc. would follow.

In 1997, aquaculture production in the Philippines was 957,546 mt representing 34.6% of the total fisheries production. During the last ten years, aquaculture production has been growing at the average annual rate of 5.4%, with a negative growth only in 1997 mainly because of problems related to shrimp disease and pollution of mussel beds. In 1997, production from aquaculture was valued at PHP 27,400 million, representing 34% of the value of total fisheries production. Export earning from aquaculture products in 1997 was USD224 million, mainly from shrimps and seaweeds. It is estimated that the total employment generated by aquaculture is over 300,000, in which women have a big share.

It is important to note that, in the opinion of the author, the definition of rural aquaculture by Edwards and Demaine does not fit in the context of small-scale aquaculture in the rural Philippines. However, aquaculture in the Philippines is mostly small-scale and household/community based operations and it contributes to food security, employment, household income and foreign exchange earnings in no small way.

LIST OF ACRONYMS

ACPC	Agricultural Credit Policy Council
ADB	Asian Development Bank
ADI	Average Daily Increment
AF	Association of Foundations
AFMA	Agriculture and Fisheries Modernization Act
AKVAFORSK	Norway's Institute for Agriculture Research
AMCFP	Agro-Industry Modernization Credit and Financing Program
APPEND	Association of Philippine Partners in Enterprise Development
BAR	Bureau of Agricultural Research
BFAR	Bureau of Fisheries and Aquatic Resources
CALF	Comprehensive Agricultural Loan Fund
CAPE	Capability and Productivity Enhancement
CARD	Center for Agriculture and Rural Development
CARL	Comprehensive Agrarian Reform Law
CDA	Cooperative Development Authority
CPD	Council for People's Development
CERDAF	Council on Extension, Research and Development in Agriculture and Fisheries
CHED	Commission on Higher Education
CLSU	Central Luzon State University
CMS	Coalition for Microfinance Standards
CPO	Council for People's Development
CTRP	Comprehensive Tax Reform Program
CWAFPI	Council of Welfare Foundation of the Philippines Inc.
DA	Department of Agriculture
DCP	Directed Credit Programs
DECS	Department of Education, Culture and Sports
DOST	Department of Science and Technology
FAO	Fisheries Administrative Order
FARMC	Fisheries and Aquatic Resources Management Council
FLA	Fishpond Lease Agreement
FP	Fishpond Permit
FRMP	Fisheries Resource Management Project
FSP	Fisheries Sector Program
GIFT	Genetically Improved Farm Tilapia
GMIT	Genetic Manipulation for Improved Tilapia
GVA	Gross Value Added
ICLARM	International Center for Living Aquatic Resources Management
IDRC	International Development and Research Center
IFARMC	Integrated Fisheries and Aquatic Resources Management Councils
ILPF	Integrated Livelihood Program for Fisherfolk
IIRR	International Institute for Rural Reconstruction
IRF	Integrated Rural Financing
LBP	Land Bank of the Philippines
LGU	Local Government Unit
LLDA	Laguna Lake Development Authority
NACFAR	National Coalition of Fishermen's Association for Reform
NAFC	National Agriculture and Fisheries Council
NAFES	National Agriculture and Fisheries Education System
NASSA	National Secretariat for Social Action
NATCCO	National Association of Training Centers of Cooperatives
NCCP	National Council of Churches in the Philippines
NCE	National Centers of Excellence
NCSD	National Council of Social Development Foundation
NESAF	National Extension System in Agriculture and Fisheries

NFRDI	National Fisheries Research and Development Institute
NGO	Non-Governmental Organization
NPPMC	Negros Prawn Producers and Marketing Cooperative
NRDSAF	National Research and Development System in Agriculture and Fisheries
NSO	National Statistics Office
ODA	British Overseas Development Agency
OPEC	Organization of the Petroleum Exporting Countries
PBSP	Philippine Business for Social Progress
PCAMRD	Philippine Council for Aquatic and Marine Research and Development
PCNC	Philippine Council for NGO Certification
PD	Presidential Decree
PFDA	Philippine Fisheries Development Authority
PHILDHRRA	Philippine Partnership for the Development of Human Resources in Rural Areas
PHILSSA	Partnership of Philippine Support Service Agencies
PHP	Philippine Peso
PO	People's Organization
PRESEED	Promotion for Rural Employment through Self-employment Entrepreneurship Development
QCOR	Quedan and Rural Credit Guarantee Corporation
RA	Republic Act
RFI	Rural Financing Institution
ROS	Research Outreach Station
SCUs	State Colleges and Universities
SEAFDEC	Southeast Asian Fisheries Development Center
SEC	Securities and Exchange Commission
SMEC	Small and Medium Enterprise Credit
SMISLE	Small Islands Agricultural Support Services Program
TAPI	Technology Application and Promotion Institute
TESDA	Technical Skills and Development Authority
TPAE	Technical Panel for Agricultural Education
TRO	Temporary Restraining Order
UNDP	United Nations Development Programme
UPLB	University of the Philippines in Los Baños
USAID	United States of America International Development
WCED	World Commission on Environment and Development

Background

The term *rural aquaculture* is broadly defined by Edwards and Demaine (1997) as "the farming of aquatic organisms by small-scale farming households or communities, usually by extensive and semi-intensive low-cost production technology appropriate for their resource base. The resource-poor base of most farms requires off-farm agri-industrial inputs to intensify production. This implies the use of inorganic fertilizers rather than formulated feed to provide low market value produce affordable to poor consumers".

At first glance the definition seems unambiguous and self-explanatory. However, when taken in the context of the Philippines, a country where fisheries is a very important industry and aquaculture is well established, where the aquaculture production base is more coastal than inland, and which has an urgent need to address widespread poverty and inequity not only in the farmlands but perhaps even more so in the coastal fishing communities, the definition given becomes severely limiting.

Within the Philippines rural aquaculture is not a distinct sector or sub-sector as far as fisheries development planning is concerned. Aquaculture is recognized as an important component of the fisheries industry and figures prominently in all fisheries development plan. Since aquaculture production units are located largely in rural areas. It is merely assumed and accepted that aquaculture development is part of rural development. Yet there is a clear need to recognize the "traditional dichotomy of development: rural or agricultural and urban or industrial" as put forth by Edwards and Demaine. This paper therefore is an attempt to provide a definition of rural aquaculture in the Philippine.

The approach taken in coming up with the definition was to review the Philippine aquaculture industry, species by species and culture system by culture system. The purpose of the review is to identify which of the different culture systems or species caught on or "clicked" into place and which failed and then to identify which can realistically be promoted for the rural poor. The review included profitability, resource required (including specifically land), technological level of development and technological skill required. On those basis a listing was then made of possible culture systems that may be considered part of rural aquaculture in the Philippines. Lastly possible rural aquaculture development projects are proposed.

Country Summary

The Philippines is an archipelagic country with some 7,100 islands. As such it has more water than it has land. With a total territorial water of 2,200,000 km^2, it only has 299,735 km^2 of land area of which 102,984 km^2 or 34% is agricultural. About 94% of the total land area is contained in the eleven largest islands of which Luzon in the north and Mindanao in the south are the two largest, Figure 1. The thousands of islands endow the Philippines with a total coastline of 17,460 km. Within its landmasses are freshwater and brackishwater swamplands, lakes, rivers and reservoirs as shown in Table 1.

The population of the Philippines stood at 68.349 million during the last national census in 1995. With an average of 1.6 million births a year, the country's population is expected to reach 76.3 million by the year 2000. About 38% of the population is below 15 years old while only 3.5% is older than 64 years old.

The labor force is 27.72 million strong in 1997, with unemployment rate at 8.7%. The largest labor force is found in the service sector at 42.5%, followed closely by agriculture with 40.8%. Only 16.7% comes from industry.

Even with a large agriculture-based labor force, the Gross Value Added from Agriculture, Forestry and Fishery is the lowest at PHP184,712 million as against PHP320,689 million from Industry as can be seen in Table 2. The Service sector has the highest contribution to the Gross Domestic Product with PHP387,615 million.

With a very low GVA and a large percentage of the population depending upon agriculture, it is evident that the farmers are likely to be the poorest. Indeed of the 32.1% of the families considered poor which is equivalent to 4.531 million families, 3.307 million comes from the rural area and only 1.246 million from the urban area. This is greatly disproportionate in view of the fact that at present, the number of rural families make up only 50.2% of the total.

Even less fortunate are the 16.5% of the total families, numbering 2.303 million considered below the subsistence level. Here the disproportion is even greater. A good 79% or 1.847 million families are found in the rural areas and only 0.488 million in urban areas.

Philippine Fisheries

Fisheries is a very important industry in the Philippines. Its importance is underscored by the fact that as of 1995 the Philippine ranks twelfth among the largest fish producer in the world. and ranks fourth in terms of aquaculture production based on figures from FAO Yearbook, 1995. In terms of contribution to the national Gross Value Added (GVA) in Agriculture, Fishery and Forestry in 1997, fisheries contributed 18.5 percent, at constant prices, as against livestock and poultry which contributed only 12.1% and 10.3% respectively. Fisheries was exceeded only by agricultural crops which contributed 54.1%. as shown in Table 3.

In 1997 the gross value at constant prices of fisheries suffered a slight decrease, at constant prices. This can be traced to the 47.4% drop in the production of black tiger shrimps, *Penaeus monodon*, from 76,220 mt in 1996 to only 40,102 mt in 1997. Meanwhile the volume of catch from capture fisheries increased by only 0.7% during the same period, not enough to offset the serback suffered by prawn culture. The previous year, 1996, the gross value of fisheries decreased by 0.48% when production from capture fisheries dropped by 4.1 percent over 1995 while shrimp production declined by 14.6%.

In spite of the recent production setbacks in fisheries the industry continues to play an important role. The country's archipelagic nature is only one of the reasons for its importance. The other reason is the Filipinos' great liking for fish. No meal is complete without fish. As a result the Philippines has one of the highest per capita fish consumption in the world at 36 kg per year of fish and fishery products (BFAR, 1997).

Philippine fisheries production has always been categorized into three modes of production for statistical and administrative purposes: commercial fisheries, municipal fisheries and aquaculture. Commercial fisheries refer to fishing done in offshore waters using fishing vessels of more than three gross tons. Municipal fisheries refer to fishing done in inland and coastal areas with or without the use of a fishing boat of up to three gross tons. Aquaculture refers to production in enclosures whether ponds, pens, cages or on substrates such as stakes, ropes, lines, nets, shells, or on a demarcated natural bed using seedstock, which may be naturally occurring, or artificially produced in hatcheries.

Philippine fisheries production has been growing, in terms of volume, at an average rate of 2.2% during the last ten years to reach 2.77 M metric tons in 1997. Of the three modes of production, aquaculture has the highest annual growth with 5.42%, followed by commercial fishing with 4.47%. (See Figure 2). Municipal fisheries, on the other hand, has been declining at an average rate of - 1.54%. As a result the contribution of aquaculture to total fisheries production has jumped from only 26.4% in 1988 to a high of 34.6% in 1997. Similarly commercial fisheries has also increased from only 26.4% ten years ago to 32 percent in 1997. In contrast the contribution of municipal fisheries has shrunk from 47.2% in 1988 to only 33.4% in 1997. (See Figure 3).

Export of fisheries products reached 173,887 mt, valued at USD549.83 million in 1997. The main export product in 1997 was tuna with 79,114 mt valued at USD171.72 million. Shrimp used to be the number one export but has fallen to second place with 10,532 mt, valued at USD129.04 million due to production failures which will be discussed in greater detail later. The third most important export is seaweeds that in 1997 reached 40,848 mt with an FOB value of USD95.1 million.

In terms of volume, import of fisheries products at 295,016 mt was higher than exports, with only 173,887 mt. However by value, imports amounted only to USD138.12 million, while exports amounted to USD549.8.. Imports consisted largely of low value item such as fish meal which reached 120,056 mt in 1997. This was followed by frozen tuna, mackerel or sardines, which are mainly for the canning industry. Thus the balance of trade in fisheries is still heavily in favor of the Philippines as shown in Table 4.

The number of persons working in the fisheries industry is estimated by the Bureau of Fisheries and Aquatic Resources (BFAR) at 990,872 as shown in Table 5. This can be an underestimate since the number of persons employed in municipal fisheries is still based on 1980 census figures and those for commercial and aquaculture on 1987 BFAR estimates. In 1980 the National Statistics Office (NSO) conducted a fisheries census jointly with BFAR. It was a very comprehensive survey that unfortunately has not yet been repeated. In 1990, only a census of population and housing was conducted. There was no special census to cover fisheries.

2.1. Historical Aspects

Rural aquaculture in the Philippine setting will be difficult to define and appreciate without having to view it against aquaculture in general. Furthermore by reviewing the history of the various species being farmed, one can see which species caught on. Hopefully one can even gather why some species are far ahead while others are left behind in terms of development. Aquaculture in the Philippines has a long history and involves many species and culture systems. Rather than present the history in a strictly chronological order which would involve jumping from one species and one culture system to another, it is here presented by species in the chronological order of their respective introductions.

2.1.1. Milkfish

The exact period when aquaculture gained a foothold in the Philippines may never be known. It is generally accepted however that the earliest fishponds were brackish water fishponds and the earliest species to be grown was bangus or milkfish, *Chanos chanos* Förskal, using naturally occurring fry that came in with tidal waters.

The generally held belief is that brackishwater fishponds probably had their origins in the island of Madura or in East Java. Herre and Mendoza (1929) cited the Dutch author C. Th van Deventer as having recorded that a Javanese law codified in 1400 A.D., already provided punishment for “him who steals from a *tambak*.” It is likely that when the Spanish conquistadors, led by Ferdinand Magellan, set foot on the island of Cebu in 1521, there were probably already fishponds on Mactan Island where he was slain. Herre and Mendoza noted that the ancient style of fishponds continued until 1921 in Mactan. The Indonesian word for fishpond, *tambak*, also means an embankment, an earthen dam or to bank up earth (Echols and Shadily, 1989). *Tambak* also means embankment, heap of earth or to pile up in Tagalog (English, 1986).

For a very long time, aquaculture industry in the Philippines was virtually synonymous with milkfish culture. And for a very long time milkfish farming remained as a brackishwater operation watered purely by tide, and relying totally on natural-food and naturally occurring, and later, wild-caught seedstock. Even under such condition milkfish farming developed into a highly sophisticated art involving a long preparation period to grow the natural food and a series of ponds to nurse the fry to fingerling stage. This eventually culminated in the development of the modular method that provides for a series of progressively larger ponds to accommodate the fish stock as they grow and at the same time allow for a certain degree of overlap between cycles. Other methods such as the stock manipulation method was introduced by an FAO expert and the deep water method by a USAID Project. However these never really caught on.

In the early seventies, milkfish farming operation expanded to include culture in bamboo and net pens set in Laguna de Bay - the country’s largest freshwater lake (Delmendo and Gedney, 1974). Then in the early 1990s, milkfish culture in fishpens spread as well to shallow marine bays and estuaries particularly in the Lingayen Gulf area. It did not take long for its culture to spread to net cages whether fixed or floating in both freshwater and marine setting.

Up to this time the technologies used were purely indigenous. However in 1996, the first Norwegian cages, heretofore used for salmon, were tried in Sual Bay, Pangasinan along the western coast of Luzon. The results exceeded expectations and now there are some 72 Norwegian cages within the area (dela Vega, 1998). Following close in its heels, the American-designed submerged cages were also introduced off the eastern coast of Luzon. The much higher cost of the latter and the 35 percent drop in the value of the Philippine peso limited its introduction to no more than three units. A local company is now manufacturing circular net-cages patterned after the Norwegian model but with innovations to suit the local conditions (Cruz, 1998).

The introduction of the marine cages has greatly expanded the range of culture systems under which milkfish is now being produced: brackishwater ponds, fishpens in freshwater lakes, fishpens in shallow bays, lake based cages whether fixed or floating, and sea-based cages. No other aquaculture species probably has a wider range of environment and culture systems under which it is being produced.

The culture of milkfish in cages depended upon and was hastened by the development and marketing of commercial feed by the feed millers. As mentioned earlier, milkfish farming for a long time depended totally on natural food. Sometime in the mid-1950s, intensive milkfish farming started in Negros Occidental, erstwhile center of the country’s intensive prawn culture operations.. The impetus was the continued setbacks suffered by the prawn growers due to diseases brought about by over-intensification. Many went back to milkfish farming. However having enjoyed the high value of prawns and having experienced the large volume of harvest in intensive prawn ponds, many were not content to go back to the fertilizer and natural food based milkfish culture system with their relatively low yield which also was very weather-dependent.

With their existing infrastructure which included huge pumps and pond aerators, it was not difficult for them to apply intensive culture techniques to milkfish. This proved to be a boon to the feedmillers who were suffering a slump in sales in prawn feed. In order to utilize their existing capacities, most if not all of them diversified their product line to include fish feed. In fact the sudden popularity of milkfish feed may have been a "technology-push" situation where the feed millers in their attempt to stay in business sold the idea of intensive milkfish culture to the losing prawn growers. Where previously milkfish farmers were content to merely use rice bran as a supplemental feed when the natural food collapses or is depleted, many now use commercial pellets.

The technology to spawn the milkfish in captivity and produce fry in a hatchery was developed in 1979 by SEAFDEC Aquaculture Department. With the initial success in rearing the fish to maturity leading to spontaneous spawning in captivity, a National Bangos Breeding Program was launched in 1985. Somehow unlike in Taiwan and in Indonesia, commercialization proved elusive. Both the banks and any would be investor were discouraged by the long gestation period involved since it takes five years for the fish to reach maturity.

It was not until 1996 when a local industrialist decided to invest in a milkfish hatchery. But when they did they turned to Taiwan for both the full-grown breeders and the larval rearing technology. Hatchery produced milkfish fry are now available but most growers still prefer to use wild fry. This is believed to be temporary. It can be recalled that there also used to be considerable resistance among prawn farmers on the use *P. monodon* fry from a hatchery.

2.1.2. Carps and Other Freshwater Fish Species

Not counting the rice paddies which in a way also served as part-time fishponds and which also has a long history, freshwater fishponds which are deliberately developed as such, probably came much later. There is no record on when the first such fishpond was established but there are records of the early introduction of exotic fish species that presumably must have been, at some time, held in some form of containment, which most likely was an earthen pond. Introductions of exotics started as early as 1905 with the three different species of mosquito fish from Honolulu, Hawaii in 1905. This was followed by the black bass *Micropterus salmoides* from California, USA.

The first exotic food fish with potential for aquaculture was introduced only in 1915 with the entry of the common carp, *Cyprinus carpio* in 1915 from Hongkong (Villaluz, 1953). These were stocked in the swamps and freshwater lakes of Mindanao in 1916 and 1918. Villaluz recounts that when 16,000 carp fingerlings from China in 1925, these were stocked in the fishpond of the then Bureau of Science. The fishpond probably refer to 10 x 20 meter rectangular tanks which were built fir use by the Division of Fisheries or the Fish and Game Division of the Bureau of the Bureau of Science (Rabanal, pers. comm.)

Since then several other freshwater fish species were introduced, including the giant gourami from Thailand in 1927 and the various plasalid species (*Trichogaster* spp.) in 1938. The big head, silver carp and the Indian carps were also introduced in the 1967 to 1968. Carp and gourami continues to be reported from freshwater fishponds, but somehow freshwater fishponds never caught on. Several species introductions and several years later the industry is nowhere the magnitude of brackishwater fishponds and remains largely a backyard type operation. It was not until the Nile tilapia was introduced and became popular that freshwater fish farming assumed some level of significance. Due to its importance Tilapia shall be discussed separately by itself in a latter section.

The failure of freshwater fishponds to catch on is probably due to two factors. One, good agricultural land is considered too valuable to be dug up for fish culture. And, two, due to the abundance of marine catch and the island nature of the country, freshwater fish is still not as widely accepted as marine fish. There are areas where freshwater fish may be preferred but these are highly localized. Until now it is not rare to find Filipinos who refuse to eat freshwater fish.

2.1.3. Oysters and Mussels

The farming of oyster in the Philippines was said to have started as early as 1931 when an oyster farm was established in Hinigaran, Negros Occidental employing the broadcast method of culture (Rosell, 1992). Then either in 1932 (Ronquillo, 1992) or 1935 (Rosell, 1992) the then Bureau of Science introduced improved methods in Binakayan, Cavite. Until now Binakayan is still a major oyster producing center. For a long while, oyster farms were confined largely to the Manila Bay area with only isolated and sporadic operations found in a few localities.

The practice has now spread to many parts of the Philippines up to Mindanao in the south. The broadcast method wherein empty oyster shells are merely scattered on the bottom of a know oyster bed is still practiced particularly in certain areas where the installation of any structure may hinder navigation as in Tinagong Dagat in Capiz, but most farms now use off-bottom techniques. The cultch, or type of substrate used range from empty shells of oysters and other bivalves to bamboo alone or in some cases used automotive rubber tires. The structure used could be as simple as bamboo stakes or could be a more elaborate set up using racks from which the cultches that are strung together with nylon monofilament fishing lines are suspended.

The farming of mussels started 20 years after, in 1955 when the Bureau of Fisheries oyster farming station in Binakayan, Cavite established a 300 m^2 demonstration mussel farm (Rosell, 1992). Prior to this the green mussels, *Perna viridis*, were regarded by the oyster farmers as pests. The fisheries personnel however realized the potentials of the species as a primary crop in itself and decided to put up the demonstration farm. With a ready market in Manila it did not take long for the mussel industry to grow. During the late 1960s, the Mr. Santos B. Rasalan then Commissioner of the Phillippine Fisheries Commission (as the Bureau of Fisheries became known at the time) reportedly also brought in green mussel stocks from Thailand and replanted these in the fisheries demonstration farm. What effect these had on the stock is not known.

It was only in the middle to late 1970s however that mussel farming spread outside the Manila Bay area. This was mainly due to the green mussels’ limited occurrence. Prior to the 1970s they were never reported outside Metro Manila. The most widespread mussel species in the Philippines is the brown mussel, *Modiolus metcalfei*. The brown mussel occurs as a dense mat on the bottom of shallow bays. Unlike the green mussel, it is not known to settle on artificial substrates, but instead prefers to settle on the valves of the grown mussels (Yap, 1979). Because of such settlement habit, it has a low potential for aquaculture and in fact has never been farmed.

Probably due to increased communication between islands, the green mussel eventually became established in other bays. They could have been unintentionally introduced through the bilge water of the ships plying the islands. Most notable are Sapian Bay and Batan Bay in the island of Panay and Maqueda Bay in the island of Samar. This did not occur until the mid-1970s. Once the their presence were noticed on fish traps and pilings, it did not take long for people in the locality to venture into their culture.

The most common method uses whole lengths of bamboo poles simply stuck into the soft muddy bottom of known mussel beds. If a good spat settlement occurs soon after installation, the first harvest can be realized in as short as six months. This method that started in Binakayan, Cavite in 1955 is still the most popular due to its simplicity. Although bamboo is now relatively expensive and sometimes difficult to find, the method still persists.

A one-hectare commercial venture using polypropylene ropes as substrates was made in Sapian Bay in 1976 to 1979, not surprisingly by one of the country's largest rope manufacturer. This can be considered a large-scale venture in as much as most mussel farms range between 300 to 1,000 m^2. Instead of hanging vertically from a raft, the ropes were formed into large 5 m long webs which were then stretched across a bamboo framework set on the bottom of the shallow bay. The farm was reported to have harvested 600 mt of mussels during the first year of operation. The farm was not sustained, partly due to marketing problems.

The use of ropes suspended from a raft similar to that of Spain or from a buoy and long line contraption similar to that of New Zealand had also been demonstrated successfully at one time or another. However the preferred method is to stake bamboo poles into the muddy bottom singly a meter apart in 2 to 10 m deep water, or in a cluster around a central pole, resembling the framework of a Native American tepee, to provide some stability.

The bulk of oysters and mussels are sold live. A small amount may be shucked and sold shell-off either fresh or salted. With improved transportation lines, mussels from Maqueda Bay on the island of Samar now reaches Manila market or even northern Mindanao.

During recent years mussel and oyster farmers have been faced with the red tide problem. Extremely rare before, red tide is now occurring with increasing regularity. It has also spread outside Manila Bay. It seems all the major mussel producing areas are now regularly having red tide blooms. Due to several deaths in the past the government has a regular red tide monitoring program. Whenever the red tide organisms exceed a certain threshold level, a complete ban is imposed on the harvesting and sale of oysters, mussels and all other bivalves. In the interest of public safety, even bivalves from a red tide free area are not allowed into the lucrative Manila market to prevent surreptitious harvesting from the red tide positive area. Needless to say the shellfish ban always wrecks havoc on the livelihood of the families relying completely on the production or trading of mussel and oyster.

2.1.4. Penaeid Shrimps

The culture of penaeid shrimps in brackishwater ponds is probably as old as the culture of milkfish since they always occur together especially when the fish farmers were still merely dependent on the entry of wild fry. Normally it will be a mixed harvest milkfish, the jumbo tiger shrimp *Penaeus monodon*; the white shrimps *P. indicus* and *P. merguiensis* and perhaps the greasy-back shrimp, *Metapenaeus ensis*. But because only a relatively small quantity can be harvested with the milkfish, it was always considered only a secondary species. It was only in 1951 when the culture of *P. monodon* as a primary species was first advocated by Villadolid and Villaluz (1951). Delmendo and Rabanal (1955), made the first documentation on their growth and their culture in brackishwater ponds.

Even after that, *P. monodon* remained in its position as a secondary species to be stocked with milkfish. The industry just could not develop fully with the meager supply of wild-caught fry. Its full commercialization has to wait for the development of hatchery technology. This was not to happen until the mid 1970s after the successful reproduction of *P, monodon* in captivity (Villaluz et al, 1972). However it was during the 1980s that the industry really took off. Fueled by a booming Japanese market, large business concerns, many with no prior exposure to aquaculture, ventured into hatchery and grow-out operation. No other aquaculture species has so captured the interest of big business. The jumbo tiger became the Philippines top marine product export earning at its peak in 1992 some USD 300 million.

With so many hatcheries being put up fry supply ceased to be a major constraint. For a short while the problem shifted to the adequate supply of quality feed. But with many feed mills getting equipped to produce prawn feed often through tie-ups with Taiwan-based companies, commercial feed became widely available. Some milkfish ponds were converted fully to shrimp farming. Others retained their fish production area or stocked shrimps together with the milkfish, or rotated shrimps with milkfish depending on the prevailing salinity. Many growers particularly in the province of Negros Occidental equipped themselves for intensive monoculture. While many more, particularly in the Central Luzon provinces of Bulacan and Pampanga, were content with low-density culture. In Negros Occidental, the rise of the prawn industry happened to occur when sugar, the province's major industry, collapsed when the Philippines lost its dominance in the world sugar market. Without any second thoughts shrimp ponds were carved out of portions of the sugar cane plantation, even if it involved the bringing in of saltwater.

With banks pouring in money for shrimp production, capital was not a problem. Even as the Philippines went through a political upheaval that started in 1983 and climaxed in 1987 with disastrous effect on the economy, there was no stopping shrimp culture development. Even a series of coup d'etats in the late 1980s failed to dampen the industry. It took an external factor - the long illness and subsequent demise of the Japanese emperor in 1989, to finally put a damper on the burgeoning industry. The price collapsed and suddenly financial projections cannot be met even if production targets could be attained. It was at this time also, when due to political instability, bank-lending rates where at their highest, often reaching more than 25% p.a. Many growers found themselves insolvent. The shrimp fever was over.

Soon after, during the early 1990s, the ill effects of pushing production to the limits using high stocking densities led to diseases, mainly luminous vibriosis. Initially the diseases could be managed with the use of antibiotics. However with unmitigated use of wide spectrum antibiotics the disease bacteria developed resistance and no amount of antibiotics would work anymore. One intensive farm after another collapsed particularly in the province of Negros Occidental, the center of intensive shrimp farming. Elsewhere many of the shrimp farms remain largely extensive. It was these farms which prevented the shrimp culture industry in the Philippines from total collapse as it did in Taiwan.

The white shrimps and the greasy-back shrimps continue to be part of brackishwater aquaculture but shrimp culture in the Philippines has become synonymous with *P. monodon* culture. There is a good price for white shrimps but the growers still have to rely on wild-caught fry. While it is easy to produce *P. indicus* or *P. merguiensis* fry, hatchery operators are reluctant to produce them because the production cost is just as high as for *P. monodon* but the fry can never be sold at the same price. Since they do not grow as big, shrimp growers will never be willing to buy white shrimp fry at the same price as tiger shrimp fry.

2.1.5. Mud Crab

The mud crab or mangrove crab, *Scylla* spp, like the penaeid shrimp is also one of the species that may be harvested together with milkfish in brackishwater ponds. However its culture as a crop in itself is fairly recent and probably dates back only to the 1960s. This was when bamboo fencing were used around a brackishwater pond to prevent them from crawling out. Culture density is typically low (20,000 per ha or lower). Previously known only as *Scylla serrata*, four distinct species are now recognized but their nomenclature is still not quite settled.

Feed used ranges from dead chickens from poultry houses to "trash fish" from capture fisheries or from brackishwater ponds such as naturally occurring tilapia which is considered a pond pest. There is no trash fish as such in the Philippines since almost all species, big or small, are utilized as direct human food. Occasionally on a seasonal basis, the catch may be so much that the selling price drops below a threshold level that makes the fish affordable as feed. Often times what passes for trash fish are those which are no longer suitable for human consumption due to poor handling. The uncertainty of trash fish supply and their often high cost forces growers to be creative in sourcing their animal protein for feeding a carnivorous species such as crabs.

With increasing demand both from both domestic and export market, more and more brackishwater fishpond operators are engaging in crab cultivation. Some operations are no more than fattening of already grown but emaciated crabs, or on-growing half-grown crabs. Some enterprising growers actually purchase the "rejects" (under-sized or under-weight), which remain unsold from the public market for this purpose.

One of the most recent method of growing crab that has emerged is mudcrab pen culture in a mangrove area. This method bears watching because it requires a very low investment and therefore can be promoted as a livelihood option for the coastal poor. This is considered a "mangrove-friendly" aquaculture system in that it does not require the cutting of any mangrove trees or extensive excavation and dike construction. Basically a net pen is installed within the mangrove forest to serve as enclosure for the crabs. Shallow trenches are dug inside the pen area to serve as refuge of the crabs during low tide, (Baliao and de los Santos, 1998; Triño and Rodriguez, 1999).

The biggest constraint to its full expansion is the supply of crab juveniles or seedstock locally called "crablets". Work on crab larval rearing in the Philippines started as early as the mid 1970s but past attempts were at most sporadic rather than sustained, and survival rates had always been low and inconsistent. Recently however work at the SEAFDEC Aquaculture Department in Tigbauan, Iloilo is yielding more consistent results with improved survival at a level which could make crab seed production economically viable. The technology as of 1998 is in the field verification stage and is in the process of being packaged for dissemination within 1999.

2.1.6. Tilapia

In 1950 the late Dr. Deogracias Villadolid, Director of the then Bureau of Fisheries, brought in the first tilapia (*Oreochromis mossambicus*) from Thailand (Villaluz, 1953).. Here was a fish which breeds so easily that anyone can be a fish farmer without having to worry about fry supply every time as is necessary with milkfish. Thus it was with the tilapia that the first serious attempt to popularize freshwater fishponds was made.

The backyard pond craze spread out through out the Philippines. Many households with enough space in the backyard or the front yard who had a ready source of water either because of a very shallow water table or the presence of a creek, dug a pond even if it was only as small as 10 m^2. Many of these ponds cannot even be drained. Its very advantage, namely the capability to breed in captivity easily, proved to be the tilapia's undoing. They proliferated inside the ponds and once over-crowded became stunted. It lost is appeal very fast and when they did, the stock that were let loose became a pest. In brackishwater ponds where they were also capable of breeding, the tilapia is considered both a competitor for food and as a predator of newly stocked milkfish or shrimps.

It is generally held that it was only with the introduction of the faster growing Nile tilapia (*O. niloticus*) in the early 1970s that freshwater aquaculture progressed beyond the sporadic backyard scale or seasonal operations in the past (Aypa, 1992). Later, the introduction of monosex culture as a means of greatly minimizing if not totally eliminating uncontrolled reproduction further made tilapia farming a profitable venture.

The earliest attempt in monosex culture used manual sexing (Guerrero and Guerrero, 1975). Experiments using androgens to produce all male tilapia fingerlings (Guerrero, 1976) showed the feasibility of its commercial application (Guerrero, 1979). The production of genetically male tilapia fingerlings using artificially produced males with YY-chromosome was the next step in monosex tilapia culture (Mair, 1994).

The use of monosex hybrids using either *O. hornorum* or *O. aureus* males and *O. niloticus* or *O. mossambicus* females, although known since 1960 (Guerrero, 1982) was not practiced or popularized. In 1971 a private grower apparently brought in *O. hornorum x O. mossambicus* hybrids from Singapore (Guerrero, 1985). There were several independent introduction of *O. aureus*, in 1977 by the Central Luzon State University, in 1978 by SEAFDEC Aquaculture Department and in 1982 by Israeli consultants of a large commercial freshwater farm in Sta. Rosa, Nueva Ecija. The performance of the *O. aureus* and *O. niloticus* hybrids in cages has already been tested (Bautista et al, 1981). Somehow however its use was never popularized and disseminated beyond the farm of the importing agency.

1988 was a landmark year in tilapia aquaculture. It was during that year that the International Center of Living Aquatic Resources Management (ICLARM) initiated a program to developed an improved strain of tilapia for low-cost sustainable aquaculture with funding from the Asian Development Bank (ADB) and the United Nations Development Programme (UNDP) which was to result in the production of GIFT or Genetically Improved Farm Tilapias (Eknath, 1994). The other collaborators to the GIFT Project were BFAR, Central Luzon State University (CLSU) and Norway's Institute for Aquaculture Research (AKVAFORSK). During the same year the British Overseas Development Agency (ODA) also funded the Genetic Manipulation for Improved Tilapia (GMIT) project. Both projects were done at the Central Luzon State University (CLSU) campus in Muñoz, Nueva Ecija. GMIT on the other hand was carried out at the CLSU Freshwater Aquaculture Center.

It was not until the mid-1990s when both projects were ready to commercialize the research results. Interested tilapia hatchery operators were invited to become accredited GIFT fingerling producers by first undergoing a training program. To continue the work of improving the GIFT Strain, producing and distributing the GIFT breeding stock as well as for licensing interested hatcheries after the GIFT Project officially closed in December 1997, a non-stock, non-profit corporation, the GIFT Foundation International, Inc. was organized (Rodriguez, 1998), to take over the functions of the GIFT Project.

The GIFT requires interested hatcheries to post a cash bond of PHP75,000 per hectare of hatchery/nursery to become licensed GIFT fingerling producers in addition to having the operator and technicians train on the use of the GIFT breeding stock. This entitles the hatchery to use a set number of breeders which continues to be owned by the GIFT Foundation. In addition the GIFT producer pays a royalty based on an agreed number of fingerling each GIFT female is estimated to produce.

Hatchery operators wishing to have their hatcheries become licensed GMT fingerling producers also have to undergo a short training course. No cash bond is required for accredited hatcheries to purchase breeding stock which are sold in sets consisting of one YY-male plus three females at PHP150.00 per set (about US$3.90). Like the GIFT the production and distribution of the breeding stock shall also be perpetuated through a Foundation.

It is however believed that the real expansion in tilapia production can come only with the development of saline-tolerant tilapia because the fishpond industry in the Philippines is virtually synonymous with brackishwater culture. It is for this reason that there has always been considerable interest among the research centers to produce a saline-tolerant tilapia strain. Early attempts showed that fast-growing, salinity tolerant fish can be produced by crossing *O. mossambicus* and *O. niloticus* (Guerrero and Cornejo, 1994; Dureza et al, 1994). It was only in 1998 that a commercial farm located in Negros Occidental started promoting a saline-tolerant all-male, hybrid tilapia fingerlings, as a viable alternative to milkfish in brackishwater or saltwater ponds. The strain the said farm is promoting is reportedly a male *O. hornorum* and female *O. mossambicus* cross.

The interest in the saline-tolerant tilapias has now gone beyond its possible use for marine cage culture or as a milkfish substitute in brackishwater ponds. The pioneering farm mentioned earlier, as part of its marketing strategy, is promoting their saline tilapia as a viable solution to the disease problems plaguing the prawn growers. The said farm demonstrated that the presence of a fairly large tilapia biomass (about 3,000 kg per ha) in both the reservoir pond and the prawn grow-out pond had an ameliorating effect on the pond environment (Domingo and Visitacion, 1998). The tilapia appears to promote the growth of a good mix of phytoplankton species and prevent the deadly Vibrio bacteria from proliferating.

Tilapia, although exotic to the Philippines, is now developing into a substitute for milkfish as a common food fish. It is gaining wider and wider acceptance and can now sell at the same level with, or at an even higher price than, milkfish. The imminent popularization of the use of saline-tolerant strains will also make tilapia as a group into an all-around fish suitable for freshwater and salt water culture and for ponds, pens, cages and in limited instances even in concrete tanks.

2.1.7. Seaweeds

a. *Caulerpa*

Seaweeds belonging to the genus *Caulerpa* (Class Chlorophyceae) are all eaten fresh in many parts of the Philippines as a tangy salad that goes well with seafood. Perhaps it is not surprising that of all the marine algae, *Caulerpa*, specifically *C. lentillifera*, is the first species to have been commercially cultivated. According to Trono (1988), the culture of “lato”, as the species is know in the Visayan islands in Central Philippines, started in the island of Mactan, province of Cebu, in the early 1950s.

Its culture was attributed to its accidental introduction with some other seaweed species (most likely *Enteromorpha*, another green algae) in fishpond as fish food. Due to the high demand for "lato" in the markets of Cebu, which even then was already an important economic center in the south, next only to Manila, it did not take long for the brackishwater fishpond operators to start its commercial cultivation.

The technology involved is simple. Existing milkfish ponds can be used for *Caulerpa* farming. Cuttings are used as planting material. These are planted one meter apart. After planting the only activities involve water management and weeding. After the cuttings shall have taken roots, frequent water exchange is necessary to maintain a fresh supply of nutrients.

Fertilization is not even necessary until at an advanced stage when the algae are almost harvestable and the natural nutrients may no longer be able to support the algal biomass. This, the farmers can tell when the color of the algae appear light green or yellowish instead of its normal healthy green color. The "teabag" method of fertilizer application which involves suspending sacks of fertilizers over strategic points of the ponds with the sack only partially submerged, has been found to be sufficient.

b. *Eucheuma*

Where the farming of the *Caulerpa* was discovered accidentally and developed due to a strong local demand, the farming of *Eucheuma* in the Philippines was developed deliberately as a response to a strong world market demand in the 1960s. *Eucheuma* is also one of the marine algae used as human food but the local demand is never that high. It is as a source of the phytocolloid, carageenan that made Eucheuma have the huge global market. Carageenan has multiple uses in the food, pharmaceutical and other industries.

According to Ronquillo (1992), *Eucheuma* cultivation started in the late 1960s when Dr. Maxwell Doty from the University of Hawaii Department of Botany came to the Philippines to assist Marine Colloids Ltd, an American company in finding a reliable supply of the seaweed. The collection and drying of the seaweed for export was encouraged to the extent that in two years the natural stock was virtually depleted.

Upon Dr. Doty's request, and with his assistance, the Bureau of Fisheries Research Division conducted trial farming in off Mindoro Island and various other locations. With the initial success family plots were established in Tapaan Island, Siasi, Sulu and later in Sitangkai, Sibutu Island.

However farming in earnest started only in 1973. This reportedly came after the discovery of mutant cultivar by a certain Mr. Tambalang which could double itself in volume every 20 days of culture and the strain became known as the "tambalang" variety. The tambalang was later recognized as a totally different species (and genus) and renamed *Kappaphycus alvarezii* in honor of Mr. Vicente Alvarez, a biologist of the BFAR Research Division who was responsible for BFAR's early effort in farming and assisting the first group of farmers in Sulu. Although taxonomically given a new genus, its cultivation is still referred to as Eucheuma farming. The term Eucheuma farming has become a generic term for the cultivation of all the carageenophyte seaweeds in the Philippines regardless of species, and it will used as such in the rest of this document, without the usual italics.

Other species thatcontinues to be cultured is the *Eucheuma denticulatum* which is a good source of iota-carageenan (a soft gelling colloid). The *Kappaphycus* is a good source of kappa-carageenan (hard-gelling) as well as lambda-carageenan (non-gelling).

The technology is fairly simple. Cuttings of the desired seaweed species are tied to a line (either nylon monofilament or polypropylene rope) at a distance of 30 to 40 cm. Each line that ranges from 4 to 7 meters is stretched taut across two stakes driven to the sea bottom or suspended at constant depth nearer the sea surface by using polystyrene foam floats. In two to three months time the first harvest can be made. Lately Eucheuma culture inside net cages to protect the crop from grazers, has also been successfully tried (Hurtado-Ponce, 1992).

The success of Eucheuma farming in the Philippines has catapulted the country to become the world's largest producer of carageenophyte seaweed. The nice thing about Eucheuma farming is that it is largely in the hands of small farmers. In a study by Posadas (1988), the estimated 2,747 farmers in Sibutu, province of Tawi-tawi (southernmost Philippine province) occupied a total area of only 2,005 hectares which means an average holding of 0.73 ha per farmer. In the province of Bohol, the 300 farmers in the Bien Unido municipality occupied only a total of 300 ha.

When the licensing of seaweed farming was still under the jurisdiction of the national government, an upper limit of one hectare per farm was set by a Fisheries Administrative Order, (FAO No. 108, Series of 1973) for individuals and 30 hectares for partnerships, corporations and cooperatives. (This has been superseded by the Local Government Code of 1991 which gave jurisdiction over municipal waters to local governments and which will be dealt with in greater detail in a relevant section).

c. *Gracilaria*

Like *Caulerpa* and *Eucheuma* the red algae *Gracilaria* is also eaten in the Philippines. However its biggest use is as a source of agar. The farming of *Gracilaria* is said to have started in Taiwan in 1962 (Trono 1988). However even earlier than that, some milkfish farmers around Manila Bay used to deliberately cultivate this seaweed in their ponds to serve as natural food for milkfish. Its commercial cultivation in the Philippines as a crop in itself must have started soon after the success of *Eucheuma* farming in 1973.

According to Trono (1988) Gracilaria can be cultivated in brackishwater ponds (salinity range: 20 to 28 ppt) using basically the same technique as that described for *Caulerpa*. Lately it has been found out that Gracilaria also grows well inside net cages set either in ponds or in open waters, (Guanzon and de Castro, 1992; de Castro and Guanzon, 1993).

There are some 17 species available in the Philippines but only two species were reportedly being gathered and used for the local manufacture of agar. But even for the two species, definitive identification has apparently not been made yet since Trono (1988) refers to the two as *G. "verrucossa"* and *Gracilaria* sp. 2. There does not seem to be a "recommended" or preferred species for culture. The available literature on its farming invariably refers only to the genus and not to the species. However Hurtado-Ponce and Pondevida (1997) found *Gracilariopsis balinae* a good species for cultivation because it produces strong, firm and rigid agar gels. Trial farming also shows a potentially high yield using the fixed bottom long line method similar to what is used for *Eucheuma* or *Kappaphycus*.

2.1.8. Giant Freshwater Prawn

The technology for the culture of giant freshwater prawn, *Macrobrachium rosenbergii*, was introduced to the Philippines during the 1970s. There were several sporadic attempts in the past to adapt the technology for its propagation but this never progressed beyond the research institution level.

In 1981 a local banker-industrialist started a large (100 ha level) commercial *Macrobrachium* farm in Sta. Rosa, Nueva Ecija in Central Luzon, with a hatchery in Bulacan, a province immediately north of Metro Manila. The company utilized the services of experts from Israel for the project. Their prawns were sold live in Metro Manila but only in their in-house retail chain selling exclusively products from the company's diverse agri-business ventures. Whether it was part of their marketing strategy or limited success in farm operations was never known. Shortly after, the company diversified their operations to include tilapia. But even the diversification failed to save the first and only commercial venture in *Macrobrachium* production in the Philippines.

While *Macrobrachium* is well accepted everywhere in the Philippines, there has never been an established market and large demand for the species. Lately the establishment of many upscale restaurants in the metropolitan areas which include a growing number of Thai restaurants, appear to have spurred renewed interest for the species.

The BFAR Freshwater Fisheries Technology Center in Muñoz, Nueva Ejija now has a regularly operating *Macrobrachium* hatchery and is supplying seedstock to a few cooperating freshwater fishponds within the Central Luzon area. A private company has recently been allowed to import *Macrobrachium* juveniles from Thailand to try out its culture and eventually start its own hatchery.

2.1.9. Rabbitfish and Spadefish

The rabbitfish, *Siganus* spp, and the spadefish, *Scatophagus argos* is cultured to a limited extent in some brackishwater ponds, marine pens and cages in some parts of the Philippines, particularly in Pangasinan. Because it is a popular food fish, some fishpond operators are tempted to stock them in empty ponds because of the availability of a large number of fingerlings during certain months of the year. Being used to milkfish many are discouraged by the relatively slow growth during the first few weeks of culture.

Two species are considered faster growing than the other species. The two are *S. guttatus* and *S. vermiculatus*. Hatchery technology is well developed at least for *S. guttatus*. But the lack of demand from the grow-out industry has deterred its full commercialization. There has been no work done yet on the propagation of *S. argos*. Since both genus are known to be low-trophic level species but are higher in value than milkfish, it is likely that sometime in the near future they will be the species to watch as growers are forced to diversify.

2.1.10. Seabass, Groupers and Other Carnivorous Fish Species

Seabass had always been an occasional part of the harvest in brackishwater ponds. Naturally occurring fry often enters through the sluice gate and are considered predators of milkfish. There were also early attempts in the mid-1970s to use seabass as a predator species in a mixed sex tilapia pond to prevent overcrowding among the tilapia. However serious attempts at farming seabass in ponds as a crop in itself started only in the mid 1980s when fingerlings started to be produced in hatcheries. The demand for seabass is strong only in the Western Visayas region in Central Philippines. In Metro Manila, the species is hardly known. Due to the weak demand, the price of seabass has never risen much higher than PHP150.00 per kg. With the high cost of feeding since there is practically no "trash fish" in the Philippines (as discussed in an earlier section), the margins are slim. Thus the industry never took off.

In contrast the culture of serranid groupers, *Epinephelus spp*., which came in later has taken hold due to a very strong export and domestic market (mainly in upscale Chinese restaurants). Live groupers can be sold at PHP300.00 to PHP350.00 ex farm. Since it costs just as much to produce a kilogram of seabass as a kilogram of grouper it is not surprising that there is a higher interest for growing groupers even if the hatchery technology for grouper fingerling production has yet to reach the commercial stage of development. The earliest attempts were apparently made by coastal fishers whose catch of live groupers may have been rejected because they were not big enough. Rather than throwing them back to the sea, these were fattened in small cages and sold when they became big enough. Up to this time this is still being done. Thus there is a market for grouper fingerlings and post-fingerlings of all sizes from the 2-cm long "tiny" to the 15-cm long XL (Extra large).

The culture of seabass and groupers came relatively late to the Philippines compared to its neighbors like Singapore, Malaysia, Thailand and Hongkong. One possible reason for its late start is the fact the growing of seabass and grouper is dependent on a constant supply of low-cost trash fish for it to be viable. As mentioned earlier there is no trash fish as such in the Philippines since even the bycatch are eaten.

In the province of Capiz (Panay island), where both pond and cage culture of grouper is thriving, the grouper growers do not depend totally on low value sea-catch for their feeding needs. In fact in some localities the growers may depend more on tilapia (*O. mossambicus*) proliferating wildly in brackishwater ponds. The use of tilapia as a feed fish has also been noted in the province of Bulacan, Central Luzon (Aypa 1992), and Pangasinan (Rice and De Vera, 1998). Being overcrowded, the tilapia stock do not grow to large sizes and are not marketable. Most will be about 50 g or even less. When prawn culture was at its heyday, these tilapia would have been eradicated by using powdered teaseed cake and the dead fish collected and thrown away. With grouper culture, a market has been created for these undersized, and previously unwanted, tilapia stock. In Capiz traders dealing with this commodity has emerged to serve the needs of the grouper growers.

2.2. Current Technological Status

Just as Philippine aquaculture industry is diverse in terms of species, culture systems and ecosystems, the level of development also varies greatly from one species to another. It ranges from virtually zero technological base as is the case with spadefish to one already at the genetic manipulation stage as with the Nile tilapia. Within species the culture system could range from extensive earthen pond systems yielding only 500 kg per hectare up to highly intensive marine cages capable of harvesting as much as 50,000 kilograms in an area measuring no more than 300 m^2 as is the case with milkfish. The species involved and the respective levels of technology and stage of commercialization are summarized in Table 6

3.1. Production Status

The total production from aquaculture in 1997 was 957,546 mt. As mentioned earlier this is equivalent to 34.6% of total fisheries production by volume as against 26.4% in 1988. During the last ten years it has been growing at an average rate of 5.42% annually with a negative growth only in 1997 as shown in Figure 4.

The negative growth in 1997 was mainly due to two commodities, shrimps and mussels. *P. monodon* production dropped by 47.4% to 41,000 mt as the industry continues to grapple with disease problems brought about by auto-pollution. Mussel production dropped by 44.6% to 11,658 mt probably due to frequent red tide occurrence during which harvesting and sale are prohibited. Contributing to the decline were tilapia and seaweeds. Tilapia production from freshwater ponds dropped by 2.7% probably due to the prolonged drought caused by El Niño. During the same period seaweed production dropped slightly by 0.7 percent apparently also due to El Niño (Anonymous, 1998). Although other species posted positive growth, notably milkfish from fishpens (31.4%) and from brackishwater fishponds (5.7%), these were not sufficient to offset the huge decreases in the mussels and shrimps.

As shown in Table 7, the 1997 production involved at least 18 species (or groups) ranging from seaweed to fish. However only four species exceeded 10,000 mt, these are seaweeds, milkfish, tilapia, oysters and mussels. Seaweeds actually consist of at least three species, two of which are actually also grown in brackishwater ponds. These are not reflected in the statistics. Neither were the milkfish produced in some 70 units of Norwegian cages installed off the town of Sual in Pangasinan. Each of these cages is capable of producing at least 30 mt of milkfish in four to five months. Together these cages have the potential of producing 4,200 mt of milkfish with an average body weight of 500 g.

3.2. Impact on the National Economy

Production from aquaculture in 1997 was valued at PHP27,400 million, and constituted 34% of the value of total fisheries production. Of some 173,887 mt of fish and fishery products exported in 1997, 51,375 mt or 29.5% were shrimps and seaweeds which are now mainly from aquaculture. The two products assume a greater significance by value. Out of a total FOB value of USD549.8 million for all fishery exports, USD224.1 million came from shrimps and seaweeds. This is equivalent to 40.8 percent of total fishery product export. Other aquaculture commodities exported include milkfish and live groupers.

Current statistics on the number of people directly employed or dependent on the aquaculture industry is not available. The last comprehensive census of fisheries was made in 1980. As mentioned at the beginning of this paper, a 1995 census on population and housing came up with figures that are hard to reconcile with the 1980 fisheries census. In the 1980 Census, it was estimated that 221,492 people were employed in the aquaculture industry that accounted for 24.1 percent of the total number employed in fisheries. The 1980 Census of Fisheries was remarkable in the amount of detail it provided regarding aquaculture operations as shown in Table 8.

BFAR has been using 258,480 as the employment figure for aquaculture since 1987. While the hectarage of brackishwater fishponds, the mainstay of Philippine aquaculture, has not increased by much since then, it is generally known that there has been an increase in the number, and more widespread application, of fish cages, although estimates on the number are not available. Fish cage culture, as practiced in many lakes in the Philippines, are much more labor-intensive than fishponds due to the more frequent feeding required.

Aquaculture also requires various support services such as gathering of wild fry in the case of milkfish and hatchery production of tilapia fingerlings. Not to be excluded are the dike-builders whose services are always required for regular maintenance work after the ponds shall have been constructed.

But perhaps the largest upsurge in aquaculture labor force may have occurred largely unnoticed in seaweed production. There has been a more than 7.5 fold increase in the production of seaweeds from only 83,000 mt in 1981 to 627,105 mt in 1997. In 1980, the Census of Fisheries reported the number of operators at 16,477 and the number of employed workers at 16,805 persons, for a total of 33,282 persons involved in seaweeed production. This places the unit production per person involved at approximately 2.5 mt seaweed per person. Even assuming that the production efficiency has doubled so that the unit per person production has reached 5.0 mt per person, the 1997 seaweed production figure still translates to some 125,421 operators and employed workers combined.

In addition to the growth of the seaweed industry, cage culture, which was still insignificant in 1980, is assuming a considerable degree of importance. The total brackishwater pond area has remained almost steady since 1980 and it is not likely that the number of people employed in brackishwater ponds would have changed much since 1980. Thus it is likely that that total employment generated by the aquaculture industry will have exceeded 300,000. While the figure may appear small realtive to the total labor force of 27.888 million, it is more than the combined labor forces of mining and quarrying (124,000) and the power and water sector (139,000).

Thus the aquaculture industry contributes to food security, employment and foreign exchange generation in no small way. It assumes even greater importance when viewed against the micro-economies of specific localities. In the municipality of Lake Sebu, South Cotabato province (Mindanao), the tilapia industry is considered the backbone of the town’s economy. The Lake Sebu town mayor in a 1994 tilapia workshop attested that the fish farming sector contributed more than 50 percent of the annual municipal income and employs ten percent of its total labor force (Loco, 1994). It is likely that Lake Sebu is not an isolated case.

and privatization of publicly owned fishpond lands. The new Fisheries Code reaffirmed the provision against further privatization of public lands first imposed in the Fisheries Decree of 1975. The last BFAR statistics in 1987 places the FLA area at 78,969 ha. Existing FLA record as of November 1998 indicates a total area of 62,625 ha. Presumably the difference represents areas where the FLA has been cancelled. This is a strong and well-funded lobby group. When BFAR issued Fisheries Administrative Order No. 125-1 in 1991 which increased the fishpond lease from PHP50.00 per hectare to PHP1,000 per hectare per year to reflect actual economic rent, the industry through the Chamber of Fisheries and Aquatic Resources was able to obtain a Temporary Restraining Order (TRO) from the Court of Appeals effectively stopping its implementation. Until now the TRO has not yet been lifted.

4.3. Fishpens

The use of fishpens is a relatively recent development. It dates back only to 1970-1971 when the Laguna Lake Development Authority (LLDA) put up a demonstration fishpen at Looc in the municipality of Cardona, Rizal province. Having demonstrated that with natural lake productivity a yield of 1,500 kg can be realized in a fishpen without even requiring fertilizers, much less supplemental feeding, the technology caught on very fast. By 1973 a total of 4,800 hectares of fishpen had been developed with a total production which was estimated to be almost equal to the production in the 85,000 hectares of open water (Delmendo and Gedney, 1973). By 1980 the fishpen area increased to 7,000 hectares (dela Cruz, 1982). By 1983 photogrammetric survey indicated that the total area occupied by fishpens was a staggering 34,000 hectares (Misagal, 1986).

Fishpens are expensive to build. In 1973, when the technology was still new, it already cost PHP8,000 to 10,000 per hectare (Delemendo and Gedney, 1973), which at that time was equivalent to US$1,100 to 1,500. The cost depends not only on the site characteristics but also the size of the pen. The smaller the pen the greater the perimeter to area ratio and the greater the cost. Alferez (1977) estimated that a one hectare fishpen would have cost at least PHP29,127, (about US$4,100). Only those with access to capital were able to invest in it. Obviously this left out those who depend solely on artisanal fishing in the lake for their livelihood, resulting in a serious social problem not too long after its introduction. An attempt was made to help the marginalized sector by providing them with the means to participate in the then burgeoning industry, through the ADB and OPEC funded Laguna de Bay Fishpen Development Project. This will be discussed at a greater length in a pertinent section.

The legal size limit for fishpens by the LLDA for individual persons is 5 ha and for corporations and cooperatives, 50 ha. By creating, what were in effect, paper corporations some groups were able to enclose several hundred hectares into one fishpen area during the late 1970s to the 1980s. Conflict with small fishers was inevitable since the pen enclosures not only effectively reduced the open area where they can still earn their livelihood but also forced them to go around the fishpen perimeter just to reach an open area where they can still fish. This required additional time and effort on their part considering that many were dependent only on wooden paddles to propel themselves. Furthermore overzealous armed guards employed by the fishpen owners often did not hesitate to shoot anyone perceived to have strayed too close to the fishpen perimeter on suspicion of being poachers.

Such acts of violence merely focused public attention on the fishpens and generated public outcry for their dismantling. There were several attempts to do just that on the part of the lake administrators. However intense political pressure from influential people, who either owned the pens themselves or are good friends of the owners, often reduced such efforts to token exercises.

It took natural and market forces to finally reduce fishpen area. Repeated typhoons reduced many of the pens to shambles. In the earlier days the fishpen owners would just have repaired the damage and continue the operation. However with more than a third of the lake surface already covered with pens milkfish growth inside the pens already suffered. Instead of taking a mere four to five months for harvest it was now taking from seven to eight months. Fishkills also became a more common occurrence. The fishpen operators started to introduce supplementary food in the form of rice bran, stale bread from bakeries and even broken ice-cream cones.

As if to add to the fishpen operators' woes, milkfish and tilapia grown in the lake seasonally acquires an earthy-muddy taste during the end of the dry season and at the onset of the rainy season. This makes it difficult to market the fish at a good price. The off-flavor was later traced to the bloom of *Microcystis* sp, a blue-green micro-algae. Under such situation, and with bamboo poles getting more scarce and expensive, it became uneconomic to invest so much for repairing the pens. Many were just abandoned and left to litter the lake surface.

At present there are only 167 fishpens registered with the LLDA. Together these fishpens have an aggregate area of 4,425 ha as shown in Table 11. Most of the fishpens are owned by corporations. It is public knowledge that unregistered fishpens still exist, but it is nowhere as rampant as it used to be in the early 1980s.

The use of fishpens has also spread to marine waters in other parts of the Philippines such as Pangasinan and La Union. These fishpens tend to be small, ranging only from 450 to 2,400 m^2. In Pangasinan the small fishpens proliferated to the extent that they started to encroach on the fishing grounds of small fishers. Their excessive use of commercial feeds started to affect the environment. In 1997 after loud public outcry 95% of some 3,000 shallow water pens and cages were dismantled by virtue of an Executive Order issued by then President Fidel V. Ramos (Velasco, 1997, Sanchez, 1997).

4.4. Cage Culture

As used in the Philippines, the term “cage” differs from “pen” in that “a cage is totally enclosed on all, or all but the top, sides by mesh or netting, whereas in pen culture the bottom of the enclosure is formed by the lake or sea bottom,” (Beveridge, 1984). Fish cages was introduced in the Philippines in 1965 when the Bureau of Fisheries first tried them out for the culture of common carp, tawes and goby in Cardona, Rizal one of the towns along Laguna de Bay (Alferez, 1977).

It is not clear when fish cages became popular in Laguna de Bay. In 1980 to 1981 it was still being tested and promoted as a poor man’s alternative to the fishpen, (Gonzales, 1984). By that time the cage design differed radically from the early versions in that instead of the movable wire mesh with wooden frame contraption, fishing net material was sewn into a rectangular bag with the top side open. The net bag is then kept taut by fastening it to a bamboo frame fixed to the bottom of the lake. The species of choice was, and continues to be, tilapia. It helped that tilapia by that time had become increasingly acceptable to the consumers. The fish cages gave the lake fishermen an opportunity to also participate in lake-based aquaculture. In 1985 the production from freshwater fishcages amounted only to 7,187 mt. This reached 35,362 mt in 1993. Production from marine cages started to be reported only in 1993. In 1997 total production from both freshwater and marine cages reached 43,000. (Figure 6)

Fish cages are simple to construct and do not require a huge investment. They can be scaled down to levels that are within reach of the poor. It is probably because of its low cost that the use of fish cages is more widespread than the fishpens. The cost of putting up fish cages varies depending on the type and size of cage. A survey in Taal Lake show from a low of PHP 9,300 for a floating cage measuring 5 x 10 m to a high of PHP28,960 for one measuring 18 x 20 m (US$ 358 to US$1,113) as shown in Table 12.

In Laguna de Bay, LLDA records for 13 municipalities around Laguna de Bay show that there are 640 registered fish cage farms ranging in size from 50 to 10,000 m^2 - the maximum allowed by law. Together these 640 farms occupy only a total area of 175 hectares, for an average of 2,734 m^2 per cage farm, with 29.0 percent ranging between 50 to 500 m^2 and 20.7 percent between 501 to 1,000 m^2 as shown in Figure 7.

In Taal Lake, an inventory conducted in 1995 showed a total of 3,140 fish cage units of varying sizes belonging to 1,138 fish cage operators. Most operators used floating cages (879) while some (212) used fixed cages. A small minority consisting of 38 operators opted for submerged cages. Unlike Laguna de Bay, most parts of Taal are relatively deep and are not suitable for fixed type of cages.

The most popular size appears to be those measuring 12 x 15 m (43%) which also occupied the largest total area (52.3%) as shown in Table 13. Cages measuring 10 x 10 m was a far second with only 21.7%. The municipalities around the lake have recently agreed on a uniform cage size of 10m x 10 m (Ms. Aypa, pers. comm). It is not known how many have complied with the new regulation. Most of the fixed cages were located along Pansipit River, the only outlet of the lake. The river-based cages were ordered demolished in 1997 to allow free access to migratory fish species and restore the river's former scenic beauty.

An earlier study (Tan, et al, 1994) categorized the fishcage operators in Taal Lake into three categories: owner-operator, caretaker and owner-operator/caretaker. The study noted that only a small percentage are of the last category. Most are either of the first two categories. It was also observed that resident owner-operators usually have one to two units, the absentee owners tend to have ten units or more.

According to several fish cage owner-operators, the caretakers in Taal Lake work under either of two conditions: a 50% share in the net operating income or a flat rate monthly salary of PHP500 per cage. Feed is the major cost in cage operation. Since the caretaker has control over the feeds, and the harvest is, more often than not, purchased by traders on an ex-farm basis, transactions are transparent. Depending on the size of cage the average net income per growing cycle ranged from PHP6,040 to PHP25,370.75 in 1995 as shown in Table 14 (UPLB Foundation, 1995).

A caretaker can reportedly take care of ten cages at a time so even if he or she opts for a monthly salary, a monthly income of PHP5,000 is already assured. This compares well with the nominal daily wage of PHP130 for non-plantation agricultural workers in Batangas province where Taal Lake is located.

A discussion on cage culture will not be complete without including the culture of groupers and siganids. In several coastal communities grouper culture has taken hold due to the high price of the species. In Roxas City, Panay Island, small fishers along Palina Estuary were able to form a thriving cooperative based on grouper culture. The Bangbang Inland Fish Farmers Multi-Purpose Cooperative consists of 54 members coming from 34 families, when visited by this author in early 1996. With a seed capital of PHP50,000 from the Roxas City government they were able to put up their own cages and attained a 10 mt harvest in 1995, which at that time would have been worth PHP2.8 million. During a second visit in 1997, it was observed that the cooperative have acquired several chest freezers to keep excess feed, an air-compressor to provide emergency aeration, and a radio communication system to contact buyers as well as suppliers of fish feed (low-value fish from capture fisheries and fishponds).

In Lingayen Gulf where groupers are also being raised in cages side by side with milkfish and siganids, the species was found to generate the highest economic rent per unit area as shown in Table 15. (Morales and Padilla,1998). The said study did not distinguish between pens and cages but it is presumed that the groupers were raised only in cages.

4.5. Seaweed Farming

One aquaculture system which appears to have benefited the most number of people in the Philippines directly as growers, rather than as hired hands, is seaweed farming, more specifically the farming of the carageenophyte seaweeds such as *Eucheuma* spp. and *Kappaphycus alvarezii.* As early as 1987 it was already estimated that in the province of Tawi-tawi alone there were 5,000 hectares of Eucheuma farms of which only 199 farms were reportedly licensed (Posadas, 1988). Eucheuma was also being farmed in 12 other provinces spread out over seven regions. By 1997 seaweed production was already being reported from 30 provinces and cities spread out over 11 of the country's 14 regions. Growth was particularly fast between 1992 and 1996 when it grew at a sustained rate at an average of 17 percent, (Figure 8).

There is no recent study on the social and economic aspects of seaweed farming to match the extent of the study conducted by Posadas in 1988. However since there has been no radical change in the technological status after the discovery of the high yielding variety known as *tambalang* in 1973, most of Posadas' observations covering the Sibutu area in Tawi-tawi and Bien Unido in Bohol, are probably still valid. These were as follows:

a) 84.3% of the seaweed farms were farmer-owned;
b) Only 22.6% were licensed;
c) Most of the farms are less than one hectare in size with an average of 0.87 ha;
d) 64.2% financed their farm with their own money, and 25.6% were financed by traders;
e) 78.3% sold their harvest to traders and the rest directly to exporters or processors;
f) Intensive farms produced more than the extensive or semi-intensive farms but were more costly to operate so that the net profit of extensive farms were relatively higher;
g) Small farms were more productive, less expensive to operate and more profitable than the medium and large farms;
h) 72.1% had fishing as their other source of income and only 4.8% had no other source of income except seaweed farming; other sources of income were farming (5.7%), trading (3.9%) and services (13.5%);
i) The educational attainment in terms of years in school averaged 5.5 years;
j) The extent of farm training averaged 4.8 hours with another 7.2 hours for processing;

Two recent analysis on the cost and returns for seaweed farming has recently been made. One was made by Hurtado-Ponce et al (1996) for *Kappaphycus alverezii* in the locality of Panagatan Cays, Caluya, Antique province (Panay Island). The other study appeared in the Fisheries Statistics of the Philippines, 1992-1996, for unspecified *Eucheuma* species, *Gracilaria* and *Caulerpa* in Bohol and Cebu and was atributed to a Policy Studies on Selected Fishery Industries conducted by the Strive Foundation (1998).

Hurtado-Ponce's study involved 43 growers who represented 72% of the total number of seaweed growers in the study area. The farm sizes involved ranged from 280 to 17,500 m^2 and averaged 3,500 m^2 per farmer. In the said study which compared the fixed-bottom method and the hanging-line method, both methods were found to be highly profitable although the hanging-line method required a higher capital investment, as shown in Table 16.

Hurtado-Ponce computed a payback period of 0.10 year for the fixed-bottom method and 0.19 year for the hanging-line method. These figures are obviously theoretical and are derived using the usual formula for computing payback period (Total Investment/Annual Net Income). Actual payback can come only after the first cropping which takes from 105 to 135 days. The first 45 days after planting is apparently for seedling expansion purposes after which it takes another 60 to 90 days to realize the first harvest. The fact that the theoretical payback period is a meaningless number is simply a demonstration of the unusual nature of seaweed farming. Very few enterprises can have an first year's net income that is from five to ten times higher than the initial investment.

The Strive Foundation economic study on seaweed farming which appeared in the Fisheries Statistics of the Philippines 1992-1996 did not have any information on the investment requirement for the Cebu and Bohol. The cost and returns was given on a per hectare per cycle basis without being annualized as shown in Table 17. In order to provide a better comparison with Hurtado-Ponce's data from Antique the said cost and returns for Cebu and Bohol is annualized in Table 18. The result shows much lower bottom line figures than those obtained by

Hurtado-Ponce. It also shows a wide disparity between production from hanging long-line and bottom culture. The farming of *Caulerpa* turns out to be comparable or even potentially better than Eucheuma farming with an annual net income of PHP88,841 as against PHP72,408 for Eucheuma farming using the long-line method in Bohol. It should be borne in mind of course that the potential market for *Caulerpa* is limited compared to that of *Eucheuma*.

The farming of *Gracilaria* yielded the lowest net income at PHP36,791 per ha per year. An earlier study made by Hurtado-Ponce et al (1992) made on eight farms in Western Visayas showed an even lower figure of PHP6,313 per ha per year when the algae is grown in a static pond. Growing them in a canal with a constant movement and entry of water was found to result in much higher yield so that net income reaches PHP41,766 per ha per year Table 19.

4.6. Mussel and Oyster Farming

Despite its fairly long history, the oyster farming industry has remained a relatively small industry in the Philippines. The same can be said for mussels. Part of the problem is the market. Unlike fish, oysters and mussels are not commodities which families would normally have as part of their daily meal except perhaps for coastal families who live along natural oyster or mussel beds. In the Philippines, they are, what may be considered, “recreational” food in the sense that they are popular for parties, picnics and drinking sessions.

There never was much of an export market to speak of to help boost the demand. In 1987, some 5,700 kg of fresh chilled or frozen and 7,609 kg of preserved oysters were exported together with some 3,382 kg of mussels. The present fisheries statistics now lump such exports with other molluscan or crustacean preparations. Sometime in 1995 a Korean company set up a large shellfish processing plant in Capiz province, Panay Island to serve the export market. This has increased the demand within the area and has perked up added interests in oyster and mussel farming. The frequent occurrence of red tide incidence on the other hand can only serve to discourage further expansion of the industry.

In the 1980 Census of Fisheries, 1,125 oyster farm and 629 mussel farms covering a total area of 460.3 ha and 230.2 ha respectively. The BFAR (1997) reported a total productive area of 227.98 ha for oysters and 381.22 ha for mussels as of 1995. Records show that during the last 12 years, the oyster and mussel production has been oscillating between 10,361 and 18,290 mt for oysters and 11,644 and 25,070 mt for mussels without any definite downward or upward growth as shown in Figure 9.

In a 1974 socio-economic study of the mussel farms in Bacoor, Cavite, Orduña and Librero (1976), 50% measured 600 meters or smaller, and the other 50% more than 600 meters in a sample of 30 farms. The smallest farm measured 327 m^2 and the largest 1.3 ha. Although dated, the said observation may still be valid considering the lack of any new development in the area. The only significant development in mussel farming since then is its spread to other bays in the Philippines where natural stocks are found. Thus in a more recent study made in Western Visayas, Samonte et al (1994) found that 81.5% were less than 1,000 m^2 in size. Most of the mussel farms still use bamboo stakes as substrate.

Oysters have a wider distribution than green mussels. Consequently oyster farms are found in more areas than mussel farms. Most are small, measuring only a few hundred square meters. In a survey by Librero et al (1976) which covered four major oyster-producing regions, the majority of the farms surveyed had areas of 500 m^2 or less as shown in Table 20. As with mussels, it appears that these observations, which were made more than 20 years ago, are still valid.

Samonte et al (1994) in a survey in Western Visayas found 72.8% of the oyster farms were below 1,000 m^2 while there were only 2.2% that were one hectare or bigger. In the earlier study by Librero et al (1976) some of the farms surveyed had existed since before 1940 while the majority were established after 1960 (Table 21).

A majority of oyster and mussel farmers has fishing as their other source of income. This was as true during a 1990 study in Western Visayas (Siar et al, 1995) as it was in 1974 (Librero et al, 1976, Orduña and Librero, 1976) as shown in Table 22.

Mussel farming appears more lucrative than oyster farming. In a survey involving 70 oyster farms and 76 mussel farms in Western Visayas, Samonte et al (1994) found that on a per 1,000 m^2 basis an oyster farm can have a net farm income of only PHP720 per year while a mussel farm can have as much as PHP4,211 as shown in Table 23. This is to be expected. Oyster farms operate in shallower areas (1.0 to 1.5 m) than mussel farms (2.0 to 7.0 m) so it can use only much shorter stakes or shorter lines and therefore offer less growing surfaces.

4.7. Rice-Fish Farming

Although the practice was never widely accepted, field trials have shown that raising fish with rice can yield a higher income than rice monoculture. Bimbao et al (1990) compared the economics of rice-fish culture with those of rice monoculture and found that economic indicators improved with the shift from rice monoculture to rice-fish culture which was taken to imply that ride-fish culture is a more profitable and productive farming system than rice monoculture (See Table 24). Ahmed et al (1992) also concluded that there are considerable economic incentives for rice-fish culture under the conditions of yields, costs, prices and farm resource endowments orevailing during the study period.

Instead of an outright integration of fish with rice, an attempt was made in the early 1980s to "re-introduce" backyard fish farming to farmers as part of an integrated approach to rural reconstruction in the province of Cavite (Southern Luzon). Fermin (1983) followed the results of thirteen participants to the project. The area was 80% planted to rice and 20% to secondary crops. Water for the fish farm came from the irrigation canal. The results showed that such a venture would most likely have a return on investment of about 55.5% in approximately 6 months. Furthermore the practice not only increased the protein intake of the participating farmers but also the community in general since approximately 90% were sold locally to co-villagers.

5.1. Land And Water Use

Land and water use in the Philippines is governed by existing laws and shall be discussed in a later section. As was mentioned earlier most fishponds in the Philippines are brackishwater ponds that were developed out of mangrove swamps. Land can be considered a premium commodity in the Philippines. Thus it is rare to excavate a good agricultural land to convert them into fishponds since this would make lower the market value of such land as a real estate.

It was only during the mid-1980s when many such conversions took place particularly in the province of Negros Occidental in Central Philippines. At that time sugarcane plantations were converted to brackishwater ponds for intensive shrimp culture. It was a time when the world market price of sugar was depressed while the shrimp market was soaring. It is not clear whether or not an environmental impact statement was required for such conversion as is required when mangroves are involved. Such conversion normally requires prior clearance of the Department of

Agrarian Reform instead. This is to ensure that the conversion is not done merely for the purpose of being exempted from land distribution under the Agrarian Reform Law.

Foreshore areas, lakes, rivers and other bodies of water are part of the public domain and cannot be claimed or titled by anybody. The use of portions of a lake, river or sea for aquaculture and other purpose requires a prior permit from the local government. The use of mangroves which are considered part of forest-lands is regulated by the national government. Freshwater resource whether from surface or ground sources also comes under the jurisdiction of the national government. A creek passing through a private property may be used exclusively by the owner of the land through which it passes, only with an appropriate license from the National Water Resources Board.

5.2. Environmental Impacts

5.2.1. Brackishwater Aquaculture

Most, if not all of the brackishwater aquaculture ponds in the Philippines were developed on mangrove swamps. It is estimated that of some 400,000 ha of mangrove forests, less than half remains untouched. Most have been developed into fishponds which later may also have been converted into shrimp ponds. The approach of most fishpond developers have been to clear-cut an area even up to the water edge in total disregard of existing regulations requiring at least 50 meters of mangrove to remain uncut. The mangrove forests which is the interface between the land and the sea is now recognized as a rich nursery ground for various marine species.

When the technology for intensive shrimp farming became available, additional stress on the environment was introduced in the form of chemicals and antibiotics used for pond preparation, pest control, prophylaxis and shrimp disease management. Then when it became evident that inter-tidal mangrove area is not really the best place to practice intensive shrimp farming after all, many good agricultural lands were also converted into shrimp ponds with the effect of actually salinizing a perfectly good agricultural land. This happened on a large scale in the province of Negros Occidental where large tracts of sugar cane plantations were converted into shrimp farms.

5.2.2. Freshwater Fishponds

Freshwater fishpond operation as practiced in the Philippines is not known to have had any adverse environmental impact. Extensive and semi-intensive operation seems to be the rule. Even if intensive culture is practiced, the wastewater should not pose any problem if this is used to irrigate croplands instead of being discharged directly to a body of water. One such intensive operation which produces more than 100 mt of tilapia in a 1.44 hectare area does just that by using the wastewater to irrigate the surrounding sugarcane plantation.

5.2.3. Fishpens

Fish containment structures in a body of water potentially pose more negative effects to the environment. Beveridge (1984) enumerated three principal ways for cage and pen structures to affect a water body:

- they take up space, thus competing with other users;
- the alter flow regimes which govern the transport of oxygen, sediment, plankton and fish larvae;
- they have an impact on the aesthetic qualities of the site.

The fishpen development in Laguna de Bay can be considered a classic case in competition for space. Competition actually occurred in two levels: one between the rich fishpen operators and the impoverished lake fishers, the other between the cultivated species (milkfish) and the natural lake biota.

The uncontrolled proliferation of the fishpens deprived the small fishers of their freedom to navigate and fish freely anywhere in the lake. This was a very acute social issue in the early 1980s when the fishpens occupied 35,000 ha of the lake's 90,000 ha area. The total fishpen area slowly dropped over the years to reach only 5,700 ha in 1989 (Zafarella, 1994). It has not grown since and may even be still dwindling. At present the registered fishpens occupy a total area of 4,425 ha based on fishpen licensing records of LLDA. Illegal fishpens still exist but are all reportedly small and probably comes up to a total of a few hundred hectares.

The competition between milkfish, the farmed species, and the rest of the lake fishes is evident when the total fish production from the lake before and after introduction of the fishpens are compared. Delmendo and Gedney (1974) found that the open water fish catch declined markedly from 433 kg/ha in 1968 to only 246 kg/ha in 1973 when fishpens were already introduced as shown in Table 25. In terms of fish catch volume, the decline was somewhat offset by the 3,999 kg per ha from the fishpens. Average unit fish production from the entire lake inclusive of the fishpen went up to 444 kg as against 434 kg per ha although total catch including crustaceans and mollusks dropped from 1,812 kg to 1,657 kg per ha.

It is in the value of the fish caught that the fishpen made a positive impact. From only PHP651 the value went up to PHP1,446 per ha. The milkfish has a much higher value than the existing fish species in the lake. The 19,204 mt of milkfish from the fishpen was worth PHP76.8 million while the 20,723 mt of miscellaneous fish from the open water was worth only PHP53.3 million. The unfortunate fact however is that while fish from the open water is free for anyone to catch, the fish in the fishpen benefited only a fortunate few.

5.2.4. Fish Cages

Unlike fishpens, fish cages are set above the bed of the body of water where they are set. Conceivably bottom fish and shellfish are free to forage under such structures. No "before and after" fisheries data has been collected for a body of water where fish cages has been introduced. However the effect of uncontrolled proliferation of fish cages in a small lake on the dissolved oxygen regime and growth of the fish in the cages in Sampaloc Lake is well documented by Santiago and Arcilla (1993).

Sampaloc Lake is one of the seven crater lakes in San Pablo City, Southern Luzon. Almost circular, the lake has a surface area of 104 ha, 3.5 km perimeter and an average depth of 20 m. After its initial introduction in 1976, the number of tilapia cages grew to occupy an area of 6 ha by 1980, as an increasing number of small lake fishers turned to fish farming. As shown in Table 26, the fish cage area doubled almost every 3 years, eventually reaching 28 ha by 1987, or 26.9% of total lake surface, even if fish growth already slowed down by the time the cage area reached 10 ha in 1982. The industry continued to grow at a slower rate until it occupied 28 ha in 1989.

In 1980 to 1981, when there were only 6 ha of cages, the average daily increment (ADI) was 1.09 to 1.12 g per day. Harvest size ranged from 200 to 250 g after 180 to 240 days in 1980; and from 167 to 200 g after 150 to 180 days in 1981. By 1982 and thereafter the ADI ranged only from 0.35 to 0.42 g per day. Harvest size ranged from 143 to 167 g after 360 to 540 days. In 1986, the fish cage operators started giving commercial feeds. This apparently enabled the fishfarmers to obtain 200 g size fish in 120 days. It is estimated that a 10 x 20 x 5 m cage (the most common size) which is typically stocked with 3,150 pieces of tilapia, consumes 1.25 mt of commercial feeds per cropping cycle. Extrapolated per hectare this is equivalent to 62.5 tons. With three croppings a year it is estimated that the lake would have received 5,250 mt of feeds from the 28 ha of cages.

Santiago and Arcilla (1993) found the dissolved oxygen in Sampaloc Lake to drop substantially below 2 m. With a DO from the surface to 1 m depth ranging from 5 to 12 mg/l, saturation level ranged from 50% to more than 100%. At 2 to 3 m, DO rarely exceeded 4 mg/l. Saturation level at 2 m occasionally reached 50%, and only 10 to 40% at 3 m. This was blamed on the weak circulation and the decomposition of organic wastes. The oxygen loss was most severe at 5 m. In 1989 DO levels were 4 mg/l equivalent to 49% saturation. In 1990 and 1991 DO level fluctuated only between 0.2 to 2.0 mg/l with saturation equivalent to <30%. The disappearance of oxygen at 3 m gave the waters at 5 m the characteristics of a hypolimnial layer which normally occurs in deeper waters. Thus even a minor agitation causing partial overturn can result in massive fish mortality as has happened several times.

The sea cages have not been introduced long enough for any adverse environmental impact to be noticed. However based upon the experiences of other countries such as with long experience in their use, such as Japan and Norway, it is known that indiscriminate installation and operation can also have serious environmental consequences in such as accumulation of organic matter on the seabed which later would undergo anaerobic decomposition.

5.2.5. Oyster and Mussel Farms

Oyster and mussel farms have been around for several decades in various parts of the Philippines. At most they take up space and impede the free flow of water, but unlike fishpens and fish cages, mussel and oyster farms do not totally exclude small-scale fishing activities. They merely limit the type of fishing gear that can be used. Although no study has been made on the build-up of silt within oyster and mussel farms, the experience of Binakayan in Cavite and Dagat-dagatan in Malabon show that long term use of an area for oyster farming makes the area progressively shallow.

They do require external inputs. For oysters these consist of bamboo poles used for stakes, nylon monofilament fishing lines for stringing up empty oyster shells used as spat collector and attachment surfaces. For mussels these would be bamboo poles and perhaps polypropylene ropes and buoys if suspended culture methods are used. But such materials are brought in at most only once during each growing cycle and in some cases are even reusable. Furthermore these materials either react slowly with, or are practically inert to, seawater. They can also be physically removed. Thus far there has been no public complaints raised against such farms.

5.2.6. Seaweed Farms

Like mussel and oyster farms *Eucheuma* farms also take up space but are mostly submerged. What are highly visible are the drying platforms and the caretakers’ huts. But such structures are often made of light, locally available materials such as bamboo and nipa palm leaf thatching and seem to blend in with the scenery. Again the exogenous inputs are similar to oyster and mussel farms: bamboo or mangrove poles, nylon monofilament lines or polypropylene rope. Polypropylene twine often referred to as “straw” is also used extensively for tying the cuttings or seedstock to the growing lines. The mangrove poles are small, normally branches from

Rizophora trees and can be obtained without cutting whole trees. Seaweed farms do not exude effluents. Instead they act as nutrient sinks.

6.1. National Policies

There is no national policy per se that is specifically addressed to rural aquaculture. What the Philippines has are policies on fisheries and aquaculture development. These are embodied in various laws, but primarily in Republic Act 8550, the Philippine Fisheries Code of 1998.

Use of public lands for fishery purposes is defined in the Philippine Fisheries Code of 1998. The said Code states that "Public lands such as tidal swamps, mangroves, marshes, foreshore lands and ponds suitable for fishery purposes shall not be disposed or alienated." Such lands however may be leased for fishpond purposes under the system known as FLA that has been discussed at length in an earlier section. The same law however prohibits the conversion of the remaining mangrove forests into fishponds thus effectively limiting the fishpond area to the area that has already been developed.

The same Fisheries Code states in the section on public land disposition that "two (2) years after the approval of this Act, no fish pens or fish cages or fish traps shall be allowed in lakes." Lake is defined by the Code to include an expanded part of a river, as well as reservoir formed by a dam, and seasonal lakes. The Code was signed into law on February 25, 1998.

Other sections of the Fisheries Code, however, still provide for specific provisions for the construction and operation of fish cages and pens. It provides for licensing by Local Government Units (LGU) and provided specifically that only ten percent of the surface area of lakes and rivers may be allotted for aquaculture purposes. The Fisheries code also spelled out the need to control the stocking density and feeding rates in such aquaculture facilities.

Those who have attended the public hearings observed that as deliberated and approved, neither the House or the Senate version had any provision banning fish cages, pens and traps in lakes. Knowledgeable quarters, including a former lawmaker, speculated that the controversial provision banning pens and cages in inland waters may have been inserted during the consolidation stage when the House version is reconciled with the Senate version after each house has approved their respective version. There is a strong feeling both among the fishery policy planners and the industry that the said provision will be removed by the legislators once their attention is called to it either through a mere action of the oversight committee or through a legislative amendment.

The Fisheries Code is silent on sea cages but only provides that all aquaculture facilities be constructed "within established zones duly designated by LGUs", and that any structure should not obstruct navigation and "defined migration paths" of migratory fish species. Curiously enough the Comprehensive Agrarian Reform Law of 1998, or CARL, in a chapter on special areas of concern specifically singled out seaweed farmers, thus: "Small fisherfolk, including seaweed farmers, shall be assured of greater access tot he utilization of water resources."

It is state policy to give preference to the poor over the use of fishery resources. Both the Local Government Code of 1991 (RA 7160) and the Philippine Fisheries Code of 1998 (RA 8550) states this explicitly. RA 7160 states that in the granting of fishery privileges within a definite zone of the municipal waters "duly registered organizations and cooperatives of marginal fishermen shall have the preferential right to such fishery privileges."

RA 8550 on the other hand states that the present FLA's for brackishwater fishponds shall be entitled to only one 25-year extension after which the new FLA shall be granted with "preference primarily to qualified fisherfolk cooperatives/associations. In another section RA 8550 states that "No new concessions, licenses, permits, leases and other similar privileges for the establishment of fish pens, fish cages, fish corrals/traps and other similar structures in municipal waters shall be granted except to municipal fisherfolk and their organizations."

6.2. Strategies and Plans

Rural aquaculture is not a recognized sub-sector of fisheries in the Philippines. Thus all existing plans and programmes are designed for aquaculture in general. In response to the stated thrusts of the new leadership after the May 11, 1998 national election, the Bureau of Fisheries and Aquatic Resources has drafted new plans for the development of the fisheries sector including aquaculture as part of, a Department of Agriculture-wide programme called MAKAMASA. The word MAKAMASA is the acronym for the Filipino name of the program that translates into "New and Abundant Harvest". The acronym itself translates into "pro-masses" to reflect the current leadership's pro-poor stance.

According to the draft document, MAKAMASA-Fisheries is "designed to develop and manage the country's fisheries resources for food security and ensure socio-economic upliftment of subsistence fisherfolk nationwide" (BFAR, 1998).

The stated purposes of the current plan are as follows:

- To improve aquaculture productivity within ecological limits;
- To optimize utilization of offshore fisheries and deep-sea resources;
- To improve product quality and reduce post-harvest losses;
- To conserve, protect and sustain management of the country's fishery and aquatic resources;
- To aleviate the poverty among municipal fisherfolks and provide supplementary livelihood;
- To provide a favorable policy environment conducive to increased investment and global competitiveness and people participation.

Except for the item on offshore fisheries all the other objectives are applicable to aquaculture development.

To attain the stated objectives the strategies are laid out as follows:

- Empower the local government units (LGUs) to assume primary responsibility for food security and direct supervision of fish production activities within their respective areas by developing provincial and municipal level fish self-sufficiency programs;
- Provide technical support for LGUs to help them attain the target yield increase;
- Make trade and fiscal incentives by the private sector;
- Focus national government support on strategic areas;
- Promote production-intensifying but cost-reducing technologies within ecological limits;
- Develop complementation and counterparting schemes with LGUs;
- Tap the expertise of state colleges and universities in accessing appropriate technologies, providing a forum for research extension linkages and assisting in the evaluation program;
- Increase in public investment particularly on post-harvest facilities;
- Improve the production-marketing systems to become more efficient and more efective;

- Produce quality broodstock, seeds and fingerlings to be made available to fisherfolks at the right time;
- Promote fisherfolk organizations;
- Conserve and protect the country's fisheries and aquatic resources.

MAKAMASA-Fisheries will rely on aquaculture to increase fish production by increasing the " productivity in brackishwater and freshwater fishponds, swamp fishery and sea cages in coastal areas". In order to achieve this "technical assistance and extension services shall be provided, and fisheries technologies disseminated." Fishfarms shall be rehabilitated and improved and seed fund for production inputs made available in the form of credit.

Quantified targets have been set. Milkfish pond productivity shall be increased to 2.4 mt/ha per year and tilapia to 4.5 mt/ha per year. This is double the present national average productivity. The aquaculture areas to be covered shall also be increased to 23,700 ha. Lastly 0.367 million broodstock and 46 million fingerlings shall be produced of which 37 million fingerlings shall be dispersed. The species involved was not mentioned but is most likely Nile tilapia and probably some common carps.

6.3. Programmes and Projects

Under the Agrikulturang Makamasa Fishries, BFAR has lined up the following programs or projects in aquaculture or has an aquaculture component:

- Fisheries Resource Management Project
- Integrated Livrhood Program for Fisherfolk (ILPF)
- Quality Fingerling Production and Dispersal
- Promotion of Sea Cage Farming
- Seaweed Development Program

These shall be discussed in more detail in a layter section.

7.1. Agencies and Organizations

7.1.1 Government Agencies Involved in Fisheries

As this paper was being prepared (Dec. 1998 to Jan. 1999), the administration and management of agriculture and fisheries was in a transition stage between old laws and newly-passed laws on agriculture and fisheries. Earlier, the Republic Act (RA) 7160, the Local Government Code of 1991 already transferred regulatory and licensing functions over municipal fisheries and agricultural and fisheries extension service to the local government. On December 22, 1997, RA 8435, Agriculture and Fisheries Modernization Act of 1997 (AFMA) was signed into law. Before its Implementing Rules and Regulations could be issued, RA 8550, the Philippine Fisheries Code of 1998 was signed into law on February 25, 1998. These three laws together will have a profound impact on the administration and management of agriculture and fisheries; research and development; extension service; as well as the management and delivery of rural credit and even fisheries education. Each of these aspects will be discussed in the appropriate sections.

The management and development of Philippine fishery resources is under the jurisdiction of the Department of Agriculture. Under the Philippine Fisheries Code of 1998, the position of Undersecretary for Fisheries and Aquatic Resources has been created in the Department of

Agriculture "solely for the purpose of attending to the needs of the fishing industry." The Undersecretary for Fisheries shall "set policies and formulate standards for the effective, efficient and economical operations of the fishing industry" and shall "exercise overall supervision over all offices related to fisheries." Two agencies, the Bureau of Fisheries and Aquatic Resources (BFAR) and the National Fisheries Research and Development Institute (NFRDI) are directly under the Undersecretary for Fisheries.

BFAR is the agency tasked with the development, conservation, management, protection and utilization of fisheries and aquatic resources. Under the Philippine Fisheries Code of 1998, BFAR shall once more exercise line functions and shall have a direct presence in the regional, provincial and municipal levels. Between 1987 to 1998, BFAR was reduced to a staff bureau with no direct hand in operations this being handled through the DA Regional Offices.

The NFRDI is a totally new agency and was created under the 1998 Fisheries Code. As of January 1999 when this paper was being prepared the said institute has not yet been organized. The NFRDI is intended to serve as the primary research arm of, but is not under, BFAR. Instead it is directly attached to the DA and shall have its own governing board with the Undersecretary for Fisheries as Chairman and the BFAR Director as Vice Chairman.

A third agency, the Philippine Fisheries Development Authority (PFDA) which is organized as a government-controlled corporation is not operationally under the DA but is under the Department's supervision. The PFDA is tasked with the management and operation of all public fishing ports, ice plants and cold storage plants.

Under the Department of Science and Technology (DOST), several sectoral councils have been organized for "the formulation of strategies, policies, plans and programs and projects for science and technology development; for programming and allocation of government and external funds for research and development; for monitoring research and development projects and for generation of external funds" in their respective sectors. One of these councils is the Philippine Council for Aquatic and Marine Research and Development (PCAMRD). The DOST also has its Capability and Productivity Enhancement (CAPE) program which provides consultants to any technology-based industry, including aquaculture.

The Local Government Code and the Fisheries Code of 1998, transferred government supervision and licensing of all types of aquaculture to the Local Government Units (LGUs), specifically the municipal government. The only licensing function left with BFAR as far as aquaculture is concerned is the granting of Fishpond Lease Agreements for public lands.

In addition to the regular agencies, there are also government-private sector councils that have been formed for fisheries. One is the National Agriculture and Fisheries Council (NAFC) which has been formed to assist the Department of Agriculture in agriculture and fisheries policy formulation. The fisheries group of NAFC consists of representatives from commercial fisheries, municipal fisheries, aquaculture, processors and exporters, research and development, and finance and credit.

The other councils are the Fisheries and Aquatic Resources Management Councils (FARMCs) at various levels: national (NFARMC), municipal or city (M/CFARMC, and bays, lakes and reservoirs bounded by two or more municipalities to be known as Integrated FARMC (IFARMC). LGUs are also authorized to form barangay (village)-level FARMCs whenever necessary. The NFARMC has not yet been formed having been created only in 1998. The creation of M/CFARMC precedes the NFARMC by a few years, but only a few municipalities so far have formed their respective councils. It is expected that the M/CFARMC and the IFARMC will have an important role to play in the sustainable development particularly of sea-based or lake-based aquaculture.

The NFARMC shall serve as an advisory/recommendatory body to the Department of Agriculture in policy formulation and the preparation of the National Fisheries Industry Development Plan. It shall be chaired by the Undersecretary of Agriculture (presumably the Undersecretary for Fisheries) and shall have as members the Undersecretary of Interior and Local Government, five members representing the fisherfolks and fishery workers, five members representing commercial fishing, aquaculture and processing, two from the academe and one representative of NGOs involved in fisheries.

The M/CFARMC shall assist in the preparation of the Municipal Fishery Development Plan and recommend the enactment of municipal fishery ordinances to the municipal council. The membership of the Council shall consist of the muncipal or city planning development officer, the Chair of the Agriculture/Fishery Committee of the municipal council, a representative of the municipal/city development council, a representative from the accredited NGO, a representative from the private sector; a representative from DA, seven municipal fisherfolk, three commercial fishers, and one fish worker.

The IFARMC has a similar role to the M/CFARMC except that their reach covers more than just one municipality. Membership is likewise similar to the M/CFARMC although it involves representatives form all the municipalities and cities concerned.

7.1.2 Private Organizations and NGOs

The Philippines is a haven for non-governmental organizations or NGOs and people's organizations or POs since the People Power Revolution in 1986. POs are membership-based while NGOs may be a private service institution or an advocacy group registered non-stock, non-profit corporations. The Securities and Exchange Commission (SEC) estimates that there are about 58,000 non-stock, non-profit organizations, even as many other similar organizations remain unregistered. From the government perspective, all these are deemed to be NGOs. Many of the POs may be registered as cooperatives with the Cooperative Development Authority (CDA) since the Cooperative Development Code (R.A. 6938) already gives them a juridical personality without being registered as corporations with the SEC although some may also have incorporated themselves as well.

The government since 1996 opened their doors to NGOs, thereby providing space in the corridors of power, no matter how narrow. The Ramos government (1992 to 1998) further increased such occasions and went one step further by establishing councils and other formal bodies with stipulated NGO and PO representation. This section is largely based on a review of the development of Philippine NGOs made by Constantino-David (1997).

In order to improve their effectivity Philippine NGOs have formed networks. One of them the National Council of Social Development Foundation (NCSD) started way back in the 1950s as the Council of Welfare Foundations of the Philippines Inc.(CWAFPI). PBSP, founded in the early 70s, is a network of business corporations as well as of those NGOs it supported. The Association of Foundations (AF) was also established during the early 1970s. The social action centers of the Catholic church formed the National Secretariat for Social Action (NASSA), the Protestants, the National Council of Churches in the Philippines (NCCP) and the Ecumenical Center for Development (ECD which was organized in 1978.

The National Association of Training Centers of Cooperatives (NATCCO), the precursor of the present National Confederation of Cooperatives, was a response to the attempts of the Marcos dictatorship to regulate cooperatives. Other sectoral, regional and national networks were also in the process of formation during this period, one of these was the Philippine Partnership for the Development of Human Resources in Rural Areas (PHILDHRRA) which was formally launched in 1983. In 1986 the Council for People's Development (CPD) and in 1988 the Partnership of Philippine Support Service Agencies (PHILSSA).

In 1990, all the networks mentioned above formed the Caucus of Development NGO Networks (CODE-NGO). With thousands of NGOs the need to police their own ranks became necessary. In 1997 the Philippine Council for NGO Certification (PCNC) was formed as a voluntary corporation and service organization whose main function is to certify non-profit organizations that meet established minimum criteria for quality service to underprivileged Filipinos (Cuyugan, 1998). The PCNC came into existence as a result of the Comprehensive Tax Reform Program (CTRP) of 1997. The Department of Finance had recommended stopping tax incentives to donor institutions under the new system, because it was felt some donors were using NGOs as tax dodges.

Expectedly quite a few NGOs are active in the fisheries sector although many are more concerned with the environment rather than on industry or livelihood development. While most, if not all, have been established for a definite geographical or geo-political area they have also formed regional and sometimes national federations. Some of the more active coalitions of fisheries NGOs are the National Coalition of Fishermen's Association for Reform (NACFAR) and the PAMALAKAYA, a national federation of fisherfolk organization working for the democratization of the fishing industry. Very few have been organized for the promotion or development of aquaculture, in fact many of the fisherfolk organization often rally against aquaculture operations especially if these are perceived to be encroaching on common fishing grounds, obstructing navigation or degrading the environment through their discharges.

Fish farmers may also organize themselves or encouraged to organize by an established NGO, to assert their rights, instill some order among themselves or obtain necessary services from the government. In San Pablo City, Southern Luzon, small fishermen turned fish cage operators formed the SPCMBY Federation in the 1980s. The initials stand for names of the six crater lakes where they operate (Sampaloc, Palacpaquen, Calibato, Mohicap, Bunot, and Yambo.). Santiago and Arcilla (1991) reported that the Federation had 700 members representing 60% of the 28 ha cage area.

Individually or as federations fisheries NGOs have been formed as advocacy groups. Many have community organizing capability but do not have technical capability for any livelihood or entrepreneurial activity. Notable exceptions are the large "traditional" NGOs which have been formed as charitable or service organizations with the resources to hire technically competent people and operate pilot or deomonstration units for a particular technology package. Two such NGOs active in promoting small-scale aquaculture technologies as an alternative livelihood for fisherfolk are the International Institute of Rural Reconstruction (IIRR) and the Philippine Business for Social Progress (PBSP).

The IIRR is a "non-profit, non - government organization that aims to improve the quality of lives of the rural poor in developing countries through rural reconstruction: a sustainable, integrated, people-centered development strategy generated through practical field experience."(IIRR and SMISLE, 1998). The IIRR recently co-produced a manual with the EU-assisted Small Islands Agricultural Support Services Programme (SMISLE) entitled "Livelihood

Options for Coastal Communities." Of the ten options presented, six are aquaculture-base: mangrove gardening, mudcrab pen culture in mangroves, lobster culture, siganid culture in fixed pens, grouper culture in floating cages and semi-intensive milkfish culture in brackish water ponds.

PBSP is an association of some 175 companies in the country that allocate a portion of their net profit to social development as well as a network of close to 500 NGOs it considers its partners. Established in 1970, it is involved in community development, small enterprise promotion, environmental conservation, agrarian reform and relief and rehabilitation. PBSP also provides training and consultancy services to NGOs and POs nationwide. Its Center for Rural Technology Development is field-testing and validating sea farming and cage culture technologies for various high-value species such as abalone, lobster, prawns and grouper in Samar (Eastern Visayas) (PBSP, 1998).

7.2. Support services

7.2.1. Educational Institutions

In a review on fisheries education made by Fernandez (1995), there were 74 schools of fisheries in the Philippines, 33 of which were part of state colleges and universities (SCUs). The rest were presumably "stand-alone" college or schools of fisheries. These institutions offer Diploma in Fisheries (3-year curriculum); and Bachelor of Science in Fisheries (4-year curriculum) with at least three majors: Inland Fisheries, Marine Fisheries, and Fish Processing Technology. Fisheries Education and Fisheries Business Management may also be offered in some schools. Aquaculture is part of the Inland Fisheries curriculum and is oriented heavily towards pond culture. Graduate program in Fisheries (Master of Science level) are offered only in two state universities and only the University of the Philippines in the Visayas offers a PhD program.

Supervision over tertiary education used to be the exclusive domain of DECS. Since 1994 supervision over technical and skills course such as the 3-year diploma courses in fisheries have been given to the newly-formed Technical Skills and Development Authority (TESDA) with tertiary level education (Bachelor's degree and higher) under the Commission on Higher Education (CHED). Only elementary and secondary education continues to be under DECS.

It is generally conceded that fisheries education in the Philippines requires considerable improvement and upgrading and that a thorough review on the continued existence of many of the fisheries schools is long overdue. The archipelagic characteristics of the Philippines motivated the Department of Education, Culture and Sports (DECS) in the past to establish Fisheries schools in various parts of the country often at the instance of politicians. As a result many have been established regardless of actual demand for fisheries graduates and a large percentage are below standard. There was also a mass conversion of fishery secondary schools into tertiary level institutions.

In an evaluation of tertiary schools in fisheries made by the Technical Panel for Agricultural Education (TPAE) in 1993 about 40% of the 129 programs in evaluated have less than 60% compliance of the minimum standards. Of the 36 SCU programs evaluated 34% have only 60 to 79% compliance with the minimum standards set by TPAE, 20% with at least 80 to 99% compliance and only 8.6% with 100% compliance. The deficiency starts with faculty quality and quantity and is aggravated by poor physical facilities. Inadequate budgetary support makes it impossible for the school library to update their holdings, and for the faculty to improve their knowledge through research along their area of specialization, and to participate in seminars, symposia and workshop to enable them to keep abreast with technology.

In addition to the fishery curriculum, another academic program that provides good basic education for aquaculture technicians for research or for industry is the marine biology program offered in some universities. Where fisheries education is exclusive to state-run institutions, marine biology is offered by some of the private universities. Many of the graduates of such program have ended up in aquaculture.

A multi-sectoral National Agriculture and Fisheries Education System (NAFES) Committee is being formed to strengthen the human resources of the agriculture and fisheries sector. The Committee has been directed to formulate programs starting with the primary and secondary schools mainly for values formation and for developing appreciation for agriculture and fisheries as career or livelihood choices and developing positive attitudes towards entrepreneurship. For post-secondary education the Committee shall look into flexible process of curriculum development; integration of dual training system in the curricula; integration of entrepreneurship and global competitiveness in the agro-fisheries curricula; institutionalizing of skill standards, technician testing and certification; as well as for the upgrading of the physical facilities and hardware for agro-fishery education.

For tertiary education, the CHED has been directed to formulate a system of accreditation for a Network for National Centers of Excellence (NCE) in Agriculture and Fisheries Education and to rationalize the whole tertiary education system in agriculture and fisheries. Only one fishery and one agriculture national university of college shall be selected as an NCE per region and only one fishery institute per province. Those not selected as NCE shall no longer be allowed to offer agriculture or fishery courses starting on School Year 1999-2000, except when jointly offered with an accredited NCE.

7.2.2. Research and Development

The passage of AFMA has led to the creation of a National Research and Development System in Agriculture and Fisheries (NaRDSAF) which shall serve to complement the National Extension System in Agriculture and Fisheries (NESAF). In order to provide an effective linkage between research and extension a Council on Extension, Research and Development in Agriculture and Fisheries (CERDAF) has been formed.

There are two national agencies concerned exclusively with fisheries and aquaculture research in the Philippines, PCAMRD and the newly-formed but still inactive NFRDI. PCAMRD is a coordinating body under the Department of Science and Technology (DOST). As such it has been tasked with the formulation of policies, prioritization of research topics and allocation of state funds for research and development. NFRDI once formed is expected to establish and operate research and development centers.

The Bureau of Agricultural Research (BAR) of the Department of Agriculture also conducts research and development work in aquaculture through its network of Fisheries Research Outreach Stations (ROS) which are located in various parts of the country. Many of the Fisheries ROS were aquaculture demonstration farms of the BFAR and under the new Fisheries Code will reportedly be reverted back to BFAR. Much of the work done in the ROS involve field trials, demonstration and technology adaptation rather than technology generation.

Under AFMA the PCAMRD is to coordinate closely with BAR in the screening of research proposals and in the monitoring of R & D projects. AFMA has directed that funding for agriculture and fisheries research should be equivalent at least to one percent of the Gross Value Added in agriculture starting in 1999 of which 20% is to be allocated for basic research and 80% for applied research and technology development. This will in effect almost double the budgetary allocation for R & D in agriculture, forestry and fisheries considering that this has been averaging only 0.58% of GVA from 1986 to 1995 (Table 27).

The presence of the SEAFDEC Aquaculture Department in the Philippines has resulted in the filling of many gaps in Philippine aquaculture research. Being a regional treaty organization, SEAFDEC AQD research program is formulated to serve the needs of the region and is arrived at through consultation with member countries. However since all the member countries belong to practically the same climatic zone and share the same species, the regional needs are, more often than not, congruent with national needs. Through a system of consultation and discussion with the industry and the local aquaculture R & D sector, SEAFDEC AQD prioritizes its research and avoids duplication of work with local institutions. SEAFDEC AQD research outputs are published mostly in international refereed journals.

Another international research organization based in the Philippines is the International Center for Living Aquatic Resources Management (ICLARM). Although not exclusively dealing with aquaculture, ICLARM was instrumental in the research and development work leading to the development of the GIFT Tilapia. The organization also actively promotes the integration of aquaculture with agriculture.

7.2.3. Extension and Training

Rabanal (1995) reviewed the aquaculture extension services of the Philippines and traced its evolution. From a national service under BFAR, the extension aquaculture technology became a function of “generalists” agricultural technicians or ATs under DA whose academic background may not be in fisheries as a result of a WB-IBRD Structural Loan Agreement. With the passage of the Local Government Code, these ATs were devolved to the local government.

Realizing the specialized nature of aquaculture and fisheries, BFAR is including extension and training services as part of the activities of the eight BFAR Technology Centers and one marine vessel, the M/V Maya-Maya. Of the eight technology centers only one is not equipped for aquaculture activities. All the rest are either exclusively for aquaculture or has capability for aquaculture technology verification and demonstration as well as for tilapia and/or carp fingerling dispersal.

These technology centers conduct farm visits and provide technical assistance to fish farmers within their vicinity. Most also hold a weekly training seminar for fish farmers. Since these technology centers are spread far apart, the greater part of the Philippines are dependent on the municipal level extension service. Whether or not aquaculture extension service is available or how well this is delivered to the end users will greatly depend on the level of support to aquaculture and fisheries and the importance given to the industry by the municipal government. With perhaps a few exceptions, most municipalities, even those where aquaculture is a relatively important industry, actually do not have such capability.

SEAFDEC AQD has a regular training program for various aquaculture technologies that are open to both government and private technicians. In addition it also responds to specific requests from government agencies to conduct specialized training. It has conducted training for fishery school teachers under TESDA as well as for former combatants of the Moro National Liberation Front in Mindanao under an FAO program.

Under AFMA agriculture and fisheries extension service has been defined to cover training, farm or business advisory, demonstration and information and communication support services. The said law requires that extension delivery be multi-disciplinary and should involve the participation of farmers, fisherfolk and their organizations. As mentioned in the previous section a National Extension System in Agriculture and Fisheries (NESAF) has been formed by virtue of AFMA.

The NESAF shall have three subsystems: national government, local government and private sector. The role of the national government (including the state universities and colleges) is to improve the effectiveness and efficiency of the LGUs through capability building and complementary extension activities. The complementary activities include technical assistance, training of LGU extension personnel, improvement of physical facilities, extension cum research, and information support services. The LGUs shall be responsible for delivering direct agriculture and fisheries extension services. NGOs and POs and other private entities particularly those with strong capabilities and track record especially in community organizing, participatory approaches, popularization of training materials, regenerative agricultural technologies, a gribusiness, marketing and management, shall be encouraged to participate.

7.2.4. Credit Sources

a. Informal

Most Filipinos rely on non-institutional lenders for their immediate cash requirements, whether for business or emergency personal needs. The term “five-six” is already part of the Filipino vocabulary in practically all parts of the country. It means paying six pesos for every five pesos borrowed. The term is normally for one month. It is equivalent to paying a 20% interest in one month. But because there are no long forms to fill up, practically no questions asked as to the purpose of the loan, no lengthy loan evaluation and is almost instantaneous, such usurious practice continues to fill a need.

The preference for informal sources of credit was evident in a survey of credit practices of small-scale fishermen in Panay, Philippines by Samonte and Ortega (1992). Of the 350 fishemen surveyed, 83% or 290 were found to have borrowed money at one time or another. Of the 290 borrowers, 97.6% relied on informal sources and only 2.4% from banks. The most common source of fund were relatives (32.0%) and friends (35.2%) as shown in Table 27. In selecting the credit source, the fishermen considered accessibility the most important factor influencing their choice as shown in Table 28.

In the aquaculture industry growers may get credit from traders. Many seaweed farmers are financed by buyers or by exporters who then get exclusive rights over the produce. Similarly tilapia cage farmers may be extended 30 to 90 day-credit for feeds by feed suppliers depending upon the economic climate.

b. Formal

Since 1987, the Agricultural Credit Policy Council (ACPC) is the institution mandated “to study, formulate, and help enact policies to improve credit flows to the agricultural sector.” It is an inter-agency cabinet level body with the Secretary of the Department of Agriculture as

Chairman, the Central Bank Governor as Vice-Chairman and the Secretaries of the Department of Budget and Management, Department of Finance and the National Economic Development Authority as members. In 1992 under Republic Act 7607, the Magna Carta of Small Farmers, the ACPC was vested with the role of administering the Comprehensive Agricultural Loan Fund (CALF) and with promoting innovative schemes for the agricultural sector.

The 1998 Fisheries Code explicitly provides funds for fisheries and aquaculture development. Five different funds are mentioned, Municipal Fisheries Grant Fund (PHP100 million), Fishery Loan and Guarantee Fund (PHP100 million), Fishing Vessels Development Fund (PHP250 million), Special Fisheries Science and Approfishtech Fund (PHP100 million) and the Aquaculture Investment Fund (PHP50 million). The last one is intended for soft loans to municipal fisherfolks and their organization who will engage in aquaculture and for the development of underdeveloped or underutilized inland fishponds. The funds are to be sourced from the national budget. The guidelines for their implementation are still under preparation.

The AFMA also mandates that an agriculture, fisheries and agrarian reform credit and financing system be designed for the use and benefit of farmers, fisherfolk, and their organizations among other beneficiaries. The law provides for the establishment of the Agro-Industry Modernization Credit and Financing Program (AMCFP). The ACPC has acccordingly reviewed all existing policies and drawn up the implementing guidelines of AMCFP, which is hoped to be launched within 1999. The AMCFP is envisioned to pave the way for the "development of a multi-track, multi-commodity, sector neutral and basically market-driven scheme to supplant all existing Directed Credit Programs (DCPs)." (Kraft, 1999).

Under the AMCFP all DCPs are to be phased out by year 2002; lending decisions and/or credit delivery will be limited only to banks and viable cooperatives and NGOs and lending rates will be market-determined to enable the conduits to cover their costs and achieve self-sustainability. As program/fund owner the Department of Agriculture will focus on the monitoring and evaluation of the AMCFP and the provision of infrastructure, institution building, research and extension, policy development, advocacy and other support services whose ultimate effect is to make smallholders in agriculture and fisheries bankable and access to credit feasible and sustainable.

During the four-year grace period for the phasing out of all DCPs, the DA shall still implement all existing DCPs.. There are three government agricultural/fisheries credit programs that are being implemented nationwide of which a third program still in the final stages of re-formulation. The two on-going programs are the Integrated Rural Financing Program (IRF) and the Integrated Livelihood Program for Fisherfolk (ILPF). The third credit program is the Gintong Ani for Local Government Units (GA-LGU) but which has apparently been replaced by the recently launched Agrikulturang MAKAMASA of which MAKAMASA-Fisheries is the fisheries component. MAKAMASA-Fisheries is directed towards two goals: income diversification among marginal coastal fisherfolk and intensification of aquaculture productivity.

The IRF is a program of the Department of Agriculture for financing agriculture and fisheries projects that was launched in 1989 with the fund administration and management of the Program handled by the Land Bank of the Philippines (LBP). The program has two distinct features: rediscounting (or lending) and institutional development. In rediscounting the LBP channels the program funds through accredited rural financing institutions (RFI), e.g. rural banks, in the form of rediscount funds. Institutional development on the other hand is aimed at giving accredited RFIs hands-on experience in organizing, developing and strengthening of small farmers/fisherfolk groups, associations and cooperatives and in so doing develop their competence and confidence in extending financial assistance to such groups (Kraft, 1998).

The ILPF was launched by the Department of Agriculture in 1997 to improve the living conditions of the small-scale fisherfolk by increasing their income through the provision of alternative livelihood projects (BFAR, 1997). It is a credit program funded by the Department of Agriculture's Credit Fund to the amount of PHP25 million and managed by the government's Quedan and Rural Credit Guarantee Corporation (QUEDANCOR). Aquaculture projects identified for financing include spirulina growing; cage culture of milkfish; grouper culture; crab fattening; aquarium fish culture; and *Gracilaria* farming.

In addition to the Philippine-wide credit programs, there are also three other agriculture and fisheries financing programs that are available only to specific areas. These are the Catanduanes Agricultural Program and the Aurora Integrated Area Development Project which are specific to the provinces of Catanduanes and Aurora, both of which are economically depressed provinces. The third is the ADB-funded Fisheries Sector Program which used to be limited to11 Priority Bay Areas but is now being expanded to 18 Priority Bay Areas covering 100 municipalities and is being renamed Fisheries Resource Management Project (FRMP). All of these include financing for aquaculture and other livelihood projects.

There are government credit programs for small and medium enterprises in general which in theory can be availed of for agricultural and fisheries ventures. These include the *Pangkabuhayan ng Bayan* of the Philippine National Bank, the Livelihood Financing Program of the Social Security System and the Promotion for Rural Employment through Self-Employment Enterpreneurship Development (PRESEED) of the Department of Labor and Employment; and the lending program of the Technology and Livelihood Resource Center. These programs are not exclusively for the rural areas.

One noteworthy credit source for small, cottage and micro-enterprise in the countryside is managed by an NGO. This is the Small and Medium Enterprise Credit (SMEC) of the Philippine Business for Social Progress (PBSP). This started with a USD12 million of revolving credit fund provided by the USAID to the Philippine Government which in turn gave the fund to the PBSP to manage. Later, PHP118.5 million was added by the Bankers' Association of the Philippines and DM 14.75 million from the Kreditanstalt fur Wiederaufbau (KfW), the German Development Bank through a tripartite agreement with the Philippine Government. By 1996 the SMEC is reported to have lent out PHP1.36 billion to small and medium businesses and created 20,000 new jobs in the countryside. The PBSP has several mariculture projects being piloted in the province of Samar. This credit facility is expected to be also available to qualified "sea-farmers" once these technologies are verified to be technically and financially viable.

Philippine banks are mandated by law (Presidential Decree 717) to set aside 25 per cent of their loanable funds for lending to agriculture and fisheries projects. According to Kraft (1998), between 1992 to 1997, agricultural loans granted averaged PHP 62,400.7 million each year of which 14.3% or PHP8,904.5 million are loans granted to fisheries. Production loans for fisheries have nominally been growing at an average of 9% per annum as against 6% for total agricultural production credit, (Table 30).

According to Bellena (1998) " the banking system has a total of PHP714 billion available for lending, PHP500 billion of which are in the hands of the big commercial banks. If the commercial banks truly comply with the law, they should have plowed PHP125 billion into agricultural lending. This should have been more than enough to saturate the borrowing needs of the whole farming sector, estimated at PHP100 billion a year." Unfortunately the compliance rate is only 21% for commercial banks and 8% for thrift banks. Even the 21% compliance rate is illusory at most because loans given out to large food processing companies and agribusiness enterprises are considered part of the agricultural loan portfolio. Official records indicate that those following the law to the letter are the rural banks, both privately owned and those owned by cooperatives, and two government banks - the Land Bank of the Philippines (LBP) and the Development Bank of the Philippines (DBP).

c. Micro-finance Institutions

NGOs involved in microfinance in the Philippines have formed a Coalition for Microfinance Standards. According to the said coalition, micro-finance is basically financial intermediation for the small borrower/saver segment. The word, although newly coined, is used to describe what has been in existence since economies started monetizing. The term also implies the application of market-based concepts such as charging market-based or cost recovery rates. In this sense, pawnshops and lending investors can be considered or are also microfinance institutions or microfinance service providers." (CMS, 1997).

There are many NGOs providing some form of micro-financing or micro-credit in the Philippines. However estimates coming from CODE-NGO, a network of NGOs, show that out of 500 developmental NGOs in the country doing micro-credit, only about 50 are pursuing micro-lending on a commercially viable basis (Rebong 1997). Some of these NGOs which are active in micro-financing are APPEND (Association of Philippine Partners in Enterprise Development), Center for Agriculture and Rural Development (CARD), and the Visayas-based Taytay Sa Kauswagan, Inc.

8.1. Highlights of Past Development Projects

8.1.1 BFAR Programs

Through the years BFAR has had several aquaculture development programs or projects. The promotion of backyard fishponds using Java tilapia (*O. mossambicus*) during the early 1950s was not exactly one of such programs. Dr. Heminio R. Rabanal, retired FAO Regional Fisheries Officer, who was then a young fisheries biologist with the Bureau of Fisheries (as BFAR was then known), recalled that the rapid popularization of tilapia culture in backyard fishponds during that time can not be credited to a national program or fisheries technology extension. In fact the Bureau of Fisheries had not yet formulated a national program for its dissemination when one enterprising newsman featured on the front page of a national newspaper, the story of a "wonder fish" that the Bureau had which can breed and grow even in small earthen ponds.

The front-page news story was enough to fire the imagination of the public and the politicians. BFAR could hardly produce enough fingerlings to satisfy the politicians who found the tilapia fingerlings a convenient way to win the favor of their respective constituents (election at that time came every two years). That is apparently how the tilapia got distributed even to the remotest towns in Mindanao. Its prolificity of course backfired when this resulted in over-crowding and stunting and the backyard fishpond lost its appeal.

During the same year BFAR launched the Blue Revolution Program which was centered on seafarming. To kick off the program, 51 demonstration projects involving mainly oysters, mussels, seaweeds, among other commodities were established in different parts of the country. BFAR (1981) reported that as a result of the program 120 individuals went into mussel farming, 47 into oyster farming and seven into tilapia cage culture. On the fifth year of the project, BFAR (1983) reported that some 1,186 oyster and mussel farm operators have been organized into a cooperative and availed of government financing, presumably under the Biyayang Dagat program.

The late 1970s to early 1980s saw BFAR involved in different aquaculture projects. One of these was the UNDP-assisted, FAO-executed Brackishwater Aquaculture Development Project which saw the establishment of four Brackishwater Aquaculture Development and Training Centers in four different regions of the country representing the four major climatic zones. The project was centered on milkfish the culture technology of which was climate- sensitive and had to be adapted to each climatic zone. The Centers which were located in Paombong, Bulacan; Pagbilao, Quezon; Calape, Bohol and Lala, Lanao del Norte were designed to be equipped with a demonstration farm, lecture hall, laboratory and dormitory. During the reorganization in 1987 when BFAR was reduced to a staff bureau these Centers, except for the one in Pagbilao, Quezon, were all transferred to the DA Regional Offices and became part of the network of DA's Research Outreach Stations under the Bureau of Agricultural Research. With BFAR regaining its line functions and regional offices these stations will come under the BFAR Regional Offices.

Another aquaculture project BFAR embarked into during the period was the USAID-assisted Fish Hatchery and Fishery Extension Center in Muñoz, Nueva Ecija. The Center is now called the National Freshwater Fisheries Technology Center and is the national center for tilapia breeding. As such it is very active in dispersing quality tilapia fingerlings and broodstock to the private accredited hatcheries and BFAR regional technology centers.

The year 1982 also saw BFAR enter into a joint-project with SEAFDEC AQD to replicate the success of SEAFDEC AQD's milkfish breeding program done in Iloilo, in other regions of the country. With funding from the International Development and Research Center (IDRC) of Canada, the National Bangus Breeding Project was originally designed to cover all twelve regions of the country. The concept was simple. Establish floating cages in sheltered coves, stock these with milkfish and grow them to sexual maturity, a process which takes from five to six years. Once they reached maturity the milkfish were to be allowed to spawn spontaneously and the eggs collected for larval rearing in hatcheries. Even if not all eggs can be collected it was also thought that some of the fertilized eggs would naturally hatch and develop into milkfish fry and help replenish the natural stock. The milkfish did develop into mature breeding stock but somehow the hatchery component in each of the site was not developed. Either the hatchery was not built at all or the technicians operating the hatchery lacked the skill. In 1993, the remaining milkfish broodstock were sold to private hatcheries.

From 1986 up to 1990, BFAR Annual Reports do not have any mention of an aquaculture development project. The ADB and OECF-assisted Fisheries Sector Project (FSP) started in 1990 but this project was oriented towards coastal fisheries resource management and aquaculture was not really given an important role.

It was not until 1991 that BFAR had an aquaculture project with the inception of the UNDP/FAO-assisted Seaweed Production Development Project (PHI/89/004). The 3-year seaweed project focused on the promotion of *Gracilaria* farming in eastern Sorsogon, at the southernmost area of Luzon. The project objectives were to develop Gracilaria farming techniques in Sorsogon, organize growers cooperative and encourage the management of the natural seaweed resources. In 1991 the project installed a Gracilaria processing plant in Cabid-an, Sorsogon. It started to buy raw seaweeds for processing. The idea was to encourage more people to go into seaweed farming through an assured market.

The seaweed project now operates as the National Seaweed Culture Center and has expanded its scope to include Eucheuma and its coverage area to all other seaweed producing areas in the Philippines.

In 1992, BFAR was a partner with ICLARM and CLSU in the development of the Genetically Improved Farmed Tilapia or GIFT. The work was conducted at BFAR's National Freshwater Fisheries Technology Center in Muñoz, Nueva Ecija. By 1994, BFAR reported that a total of 114,450 GIFT breeders have been distributed to accredited hatcheries. The GIFT Project is now an independent foundation and has continued the breeding and distribution of GIFT breeders.

8.1.2 Fishpond Estate Project

A wider participation in brackishwater fishpond operation by smallholders has always been a dream of Philippine fisheries planners. One way of achieving this, it was thought was for government to develop small fishponds for distribution to smallholders through some financing plan together with technical and marketing support. In 1973, when the Philippines was under one-man rule, then President Marcos issued Presidential Decree No. 43-A to amend PD No. 43 "providing for the accelerated development of the fishery industry". PD 43-A had two main features: the creation of a Fishery Industry Development Council and the construction and development of family-size fishponds. The decree identified potential areas where a fishpond estate can be established.

The said decree also encouraged fish canning companies to venture into such development by offering them the privilege of occupying 1,000 ha instead of the maximum of 500 ha, exempt from paying the annual lease rental. As far as can be ascertained no fish canning company took the offer.

Following the decree, two foreign companies (one Taiwan based and another US based) undertook a feasibility study on the conversion of a 1,200 ha mangrove area in Vitali, Zamboanga City into a smallholder fishpond project in 1975. Vitali was one of the four areas identified by the decree as potential fishpond estate sites. The Vitali area was to have been divided into 217 individual milkfish ponds each about 5 ha in size. The project study was submitted to the BFAR in March 1975 but nothing came out of it probably due to the lack of funding.

It was not until the early 1980s when the idea was revived. The Southern Philippine Development Authority (SPDA) obtained the right to use the Vitali area and commissioned a local consulting company to do a feasibility study. This was the time shrimp culture was taking off. The concept was changed into shrimp farming instead of milkfish farming. With a higher value crop, smaller ponds could be built for distribution to a greater number of families. The intended beneficiaries would have been "rebel-returnees" from the Moro National Liberation Front then fighting a war in Mindanao. The project would have included a *P.monodon* hatchery to supply the fry required and a feedmill to produce its own feed. Construction was initiated and more than 100 ha of the 1,200 ha were apparently completed when the project was halted apparently due to funding problems. SPDA never got to the distribution stage and merely operated the completed portion as a corporate farm and later leased it out to private operators.

8.1.3 National Rice-Fish Farming Program

In 1979, the Department of Agriculture launched the National Rice-Fish Culture Program under the catchy name of "Palay-isdaan". It was a clever play of words in that the unhusked rice and the rice plant in Tagalog is “palay” and “palaisdaan” is the term for fishpond. The program was aimed at increasing the income of rice farmers and improving their nutritional status (Sevilleja, 1992).

The technology was provided by the Freshwater Aquaculture Center. The rice field was modified by digging a half-meter deep trench longitudinally across the center of the field and the dikes were made slightly higher and wider than for conventional rice farming. A screened gate was provided to prevent the cultured fish from escaping and extraneous from entering. Nile tilapia or the common carp were stocked either singly or in combination at densities of 5,500 to 9,900 per hectare. The farmers used high yielding IRRI rice varieties but did not apply the required type or amount of fertilizers. Occasionally supplemental feeds, mainly rice bran were reportedly given. The participating farms harvested on the average 4,825 kg of rice and 232 kg of fish per hectare. The economics of the rice-fish culture has been discussed in an earlier section and is shown in Table 24.

Modestly aimed at 931 ha in 41 selected provinces in all the regions of the country, the program went off to a slow start with only 193 ha involved during the initial six months of implementation. Eventually by 1982 some 1,397 ha were covered but the next year the total area went down to 759 ha. As shown in Table 31, the total area slowly dwindled year by year eventually dropping down to 185 ha in 1986, the last year the program was monitored.

As cited by Bimbao et al (1990), an unpublished status report of the said program blamed the failure on the prevalent use of high-yielding rice varieties that needed heavy use of fertilizers and pesticides. Although demonstration after demonstration has shown the practice to be more profitable than rice monoculture, rice-fish culture has not really progressed beyond the field testing and verification stage. The low adoption rate has been blamed by Ahmed et al (1992) on several technical and social constraints:

- Indiscriminate application of pesticides;
- Short rice production cycle resulting in small fish at harvest;
- Unavailability of fingerlings;
- Inadequate water supply;
- Poaching;
- Risk averse attitude of most farmers.

8.1.4 Laguna de Bay Fishpen Development Project

The Laguna de Bay Fishpen Development Project was conceived by the Laguna de Bay Development Authority (LLDA) as a means to provide an opportunity for the small-scale fishermen in Laguna de Bay to participate in the lucrative fishpen industry as part of the Laguna de Bay Development Program that was formulated with UNDP assistance. The Philippine Government submitted the proposal to ADB for possible financing in 1976. The Bank approved a loan of $9.0 million in 1978 to finance the development of 2,500 ha of fishpen for distribution to deserving families. During the same year the Organization of Petroleum Exporting Countries Special Fund also agreed to provide $4.5 million.. The Development Bank of the Philippines was the conduit bank to administer the sub-loans (in the form of fishpens and fish cages) to some 1,550 beneficiaries.

The Project involved the construction of 550 modules of 5 and 10 ha fishpens for milkfish culture covering 2,500 ha. The ten-hectare modules were to be operated by groups of 4 to 5 beneficiaries, and the five-hectare modules by 2 to 3 beneficiaries. In addition each beneficiary was also to be provided with fish cages for tilapia culture for individual operation. The projects also involved the development of a hatchery-nursery complex to supply the required milkfish and tilapia fingelings and a feedmill to supply feeds.

During the implementation stage the project encountered innumerable delays so that in 1983 it had to be re-appraised by ADB to determine whether or not it should be continued or terminated. The re-appraisal mission recommended an extension of 18 months, (Medina, 1984). By that time the area occupied by private fishpens had mushroomed to more than 30,000 ha. This forced the Project to scale down by one third to 1,680 ha and for most of the fishpens to be located in less than ideal areas which were more exposed or were less productive. Due to many other factors, the lake's plankton productivity had already declined by that time which resulted in longer grow-out periods. The project was not considered completed until 1988.

A project performance audit report on the project (ADB, 1989), noted that no project component achieved an output greater than two per cent of appraisal projections and almost all of the fishpens have failed. About 99 percent of the Project pens have been destroyed mainly during severe typhoons. As a result, the poor fishermen the project intended to benefit sustained heavy losses and ended up owing PHP1.2 milion per 10 ha fishpen. Only some three-tenths of one per cent of the capital and accumulated interests had been paid back. The hatchery-nursery complex was never in full operation and had produced only at two per cent capacity. Although even without the fishpens, it could have been operated independently to recover some of the investment, it is now idle.

In addition to the natural factors such as typhoons and the proliferation of water hyacinth part of the problem apparently were the bank's and the government's rules and procedures which hampered Project's ability to respond in a timely manner. While private pens could be built in less than one month, the project required several months since international bidding procedures have to be followed. When a fishpen is destroyed by typhoons, procedures for obtaining government funding and procuring materials have to be followed again. The same was true in the procurement of fingerlings.

8.2. Current and Planned Projects with Aquaculture Component

8.2.1 Fisheries Resource Management Project

There is no project as such that is solely devoted to rural aquaculture or even aquaculture in general. However the ADB and the OECF-funded Fisheries Resource Management Project (FRMP) of BFAR has a mariculture support component. The FRMP is a successor project to the Fisheries Sector Program (FSP) that was also funded by ADB which was completed in 1996. Originally scheduled to run from 1998 to 2003, the FRMP was still in the consultant-selection stage when this paper was being prepared (Nov 1998- Jan.1999). Its long-term goals are "to achieve sustainable development of the fisheries sector, and reduce poverty among municipal fisherfolk." The project's primary objective is "to reverse the trend of fisheries resource depletion in municipal waters." (FRMP, undated).

The FRMP shall cover 18 bays, 11 of which were previously covered under FSP. All in all the 18 bays will cover 100 municipalities.One of its strategies to reduce fishing pressure on the nearshore waters is to provide support for mariculture development as a means of providing fisherfolks other sources of income outside of fishing. Possible aquaculture projects that have been tentatively identified during the project formulation stage include cage culture of milkfish; cage culture of groupers; *Eucheuma* culture; *Gracilaria* culture; mudcrab farming; mussel culture and oyster culture.

8.2.2 Integrated Livelihood Program for Fisherfolk (ILPF)

The ILPF is basically a financing program and was discussed earlier in the section on credit. It provides alternative livelihood to municipal fisherfolk as a means of reducing the fishing pressure on nearshore fisheries. Among the alternative livelihood identified for financing are several aquaculture projects which has previously been enumerated.

8.2.3 Quality Fingerling Production and Dispersal

The production of quality fingerlings is a continuing program of the national aquaculture centers and demonstration stations of BFAR. The species are mainly carp and tilapia. Fingerlings produced are either sold to growers at nominal cost or used " to regularly replenish inland waters, bays and gulfs"

8.2.4 Promotion of Sea Cage Farming

Sea cages shall be promoted as an alternative livelihood to fishing and to increase fish production. Two types shall be promoted, floating net cages for the culture of milkfish, grouper, siganid and seabass; and net pens for the culture of finfish and crustaceans.

8.2.5 Seaweed Development Program

This program is aimed at further developing the seaweed industry through enhanced research and development. The projects to be undertaken under this program include inventory and assessment of seaweed resources, seaweed farming, product technology development, marketing and manpower development.

8.3. Women in Aquaculture

Aquaculture in the Philippines is gender-neutral in some aspects and male-dominated in other aspects. There are many women who are themselves involved as owner-operator and are active in the management of fishponds and fishcages. A cursory glance at the names of fishpond lease agreement holders reveal many female names. But one can never find a woman building dikes and installing pens and cages. In the fishcages in Taal Lake one can see as many women feeding the fish as there are men but one can never find women lifting sacks of feed and boxes of fish. Seaweed farming involves many women in the tying of the seaweed propagules to the growing lines. In Tawi-tawi one can find many women caretakers in the seaweed farms.

Siar et al (1995) in a study of oyster and mussel farming in Western Visayas found that 18.5% of oyster farmers were female but only 2.4% of mussel farmers were, as shown in Table 30. This disparity was explained as being due to the fact that oysters are usually grown in shallow parts of a river while mussels are grown in deep portions of the bay. It was also noted that more males than females are involved in the strenuous tasks of staking, raft and rack construction. Boring and stringing of oyster shells for use as cultch was observed to be a household actvity involving women and children. The same was true in the shucking of harvested oysters. Engaging the children in these tasks was thought to be a woman's way of integrating child care with household tasks and income-generating activities.

Women play a major role in the marketing of fishery products in the Philippines. Siar et al (1995) notes that this strengthens the role of women as financial managers within households and recommended that women be included as target group in extension activities, especially those relating to the improvement of postharvest handling and the development of entrepreneurial skills.

The Philippines has a vast potential for aquaculture development. With the dwindling catch from coastal waters, the uncertainty of sustaining the present level of deep sea fisheries and the increased competition for fish resources in international waters leading to border conflicts, aquaculture remains the only hope for self-sufficiency in fish and for maintaining or even increasing the role of fish in food security.

Aquaculture also is the most logical livelihood option for the small fisherfolk who can no longer catch enough fish even to feed themselves. As it is now the aquaculture industry in the Philippines is still mainly in the hands of the rich and the privileged. There is a real need to widen the ownership base of aquaculture production systems and make the industry one of the livelihood options in the rural area whether inland or coastal.

9.1. A Redefinition of Rural Aquaculture Systems in the Philippine Context

Based on the definition of Edwards and Demaine (1997), for an aquaculture activity to be classified rural it should ideally meet the following requirements:

- it is done by small-scale farming households or communities;
- it uses extensive or semi-intensive low cost production technology;
- it may use off-farm agricultural inputs such as inorganic fertilizers to intensify production;
- it avoids the use of formulated feeds;
- it produces a commodity which must be of low-market value affordable to poor consumers.

If this definition were to be strictly applied most of Philippine aquaculture cannot be considered part of rural aquaculture. Yet without a doubt many such aquaculture activities are in fact rural in nature. The given definition appears to be oriented towards aquaculture units that are based in, or integrated with, agricultural farming units rather than as stand-alone aquaculture units. Other than the freshwater fishponds, all other aquaculture systems regardless of scale and ownership, while definitely not industrial cannot be considered rural aquaculture either under the given definition. Even the seaweeds farm and the oyster and mussel farms, which are mostly small-scale, do not quite fit into the definition. The seaweeds, particularly the *Eucheuma*, while of relatively low value, are mostly sold, not to poor consumers, but to processors and exporters. Oysters and mussels, while cheap to produce, have much potentially higher market values than poor consumers can afford and are in fact set up more to generate cash than to produce food for the family.

If rural aquaculture is limited to freshwater fishpond then in its present state it is a very small base for rural aquaculture in the Philippines. The total freshwater fishpond area in the entire Philippines is 14,531 ha of which two thirds are in the Central Luzon region only, making up 0 14% of total fish and shellfish production from aquaculture. Thus such a restrictive definition is not realistic in the Philippine context.

There is a need to encourage freshwater aquaculture in the Philippines particularly small-scale aquaculture integrated with agriculture. However this should be done without leaving the impoverished fishing communities behind.

The Philippines, an archipelagic country, with a strong tradition for coastal aquaculture requires a broader definition of rural aquaculture. The definition should be centered more on the ownership and control of the means of production rather than on trophic level consideration of the species involved and on the cost of the final product and target market. There is an inherent fallacy in insisting that the poor should only produce for the poor, except if the intention is to keep them poor in perpetuity. Aquaculture should be viewed as a means for the rural poor to be more financially secure so that they can afford to provide themselves with more than just food, clothing and shelter.

In the Philippines this is nowhere more acute as in the coastal area. Municipal capture fisheries had been declining at an average rate of 1.54% since 1992. There is no sign of recovery and there is not likely to be unless drastic measures are taken to reduce the fishing pressure. Aquaculture is a viable alternative to fishing. With coastal aquaculture the fishing families will still be in working within the environment and commodities that they are familiar with. As already discussed in an earlier section most of the oyster, mussel and seaweed farmers had fishing as their previous or their concurrent means of livelihood.

Additionally, in the Philippine situation, there is no choice but to provide the poor with water-based livelihood, whether in lakes or in marine waters. So much land is still in the hands of the rich. There is still a very strong resistance on the part of those who are in a position of power and influence to have these lands equitably distributed. Even the public lands that have been converted to fishponds are mostly large tracts that are not under the control of the local people or community but by an absentee leaseholder. To make matters worse fishponds are exempted from agrarian reform. The lakes and the seas at least are still common property.

Thus a less restrictive definition of rural aquaculture is in order so that any future program to help this sector will benefit a larger number of people or families. For the Philippines rural aquaculture should include the farming and husbandry of aquatic organisms which meet the following conditions:

- it is done by small-scale farming or fishing households or communities;
- it uses production technology appropriate for the area and for the species;
- it will not result in additional pressure on the local resources and will not infringe on the nutrition and/or livelihood of others;
- it will help alleviate poverty.

9.2. Production Systems, Facilities, Species

Under the foregoing conditions the following culture systems should be considered part of rural aquaculture in the Philippines:

a) small-scale freshwater fishponds that are part of agricultural farms;
b) culture of fish in cages;
c) oyster and mussel culture;
d) open-sea seaweed culture (as opposed to pond-based);
e) culture of any edible or marketable species in swamps, marshes, mangroves (e.g. mud crab culture in mangrove-based pens).

The non-inclusion of stand-alone freshwater fishponds and all brackishwater fishponds will reduce ambiguity as to the target sector. While there may be small-scale stand alone freshwater fishponds and brackishwater fishponds these are exceptional. Under the present socio-political system it is not likely that the number of such small pond holdings can still increase or can be increased. The only way a brackishwater pond system could be made part of rural aquaculture is by developing it specifically for smallholders using the nucleus-estate concept. However this type of development is expensive and the Rate of Return is not likely to be attractive. It also suffers from a long gestation period since it takes time even just to rehabilitate or convert existing fishpond to small holders ponds

On the other hand while it is true that many of the present fish cages are not owner-operated, it is realistic to offer such culture system as an alternative livelihood to coastal or municipal fishing since the investment required is minimal. Oyster, mussel and seaweed farming, as has been determined in various surveys, are mostly small-scale and family operated and should therefore be considered part of rural aquaculture. It should be noted that NGOs involved in rural development such as the Philippine-based International Institute for Rural Reconstruction (IIRR) and the PBSB are also partial to cage culture, seaweed culture and other types of culture systems which are not land-based, as livelihood alternatives for the coastal poor.

10.1. Rice and Fish Project

Freshwater aquaculture in the Philippines is under-developed especially when compared with brackishwater aquaculture. It still has a considerable opportunity for growth. The most logical places where freshwater aquaculture can be developed are the country's irrigated rice farm areas, which according to latest statistics has a total area of 1,558,158 hectares. There is a need to re-introduce and promote rice-fish culture inspite of the failures of early attempts. Field trials repeatedly show the profitability of rice-cum-fish culture when compared to rice monoculture. The lack of acceptance among the farmers had been attributed to several reasons, among them, inadequate water supply from the irrigation system, incompatibility with the use of pesticide, the short culture period of high-yielding rice varieties which does not give enough time for the fish to grow to optimum market size, and lack of fingerlings at the exact period required.

In order to improve the project's probability of success the proposed project should select only areas where the irrigation system is well developed and the water supply adequate or areas which are irrigated using shallow-tube wells. The farmers should be given two options, raising the fish together with the rice or raising the fish apart from the rice with the water serving as the common resource between the two. Such a project should be pushed not only by BFAR but by the Department of Agriculture through the LGUs with BFAR providing the technical backstopping for the fish culture component. Such a project should have the following components:

- Demonstration farms in selected areas perhaps using farmer-cooperators rather than government stations. Two different methods can be demonstrated: fish cultured together with the rice in the same compartment; and fish cultured separately from the rice with the water supply for the rice passing through the fishpond.
- Seminar for Municipal Mayors on the Project;
- Training of Municipal Agriculturists by the Agricultural Training Institute with resource persons from the Bureau of Plant Industry and Bureau of Fisheries and Aquatic Resources on the technology and on its dissemination
- Training of participating farmers by Municipal Agriculturists on the technique;
- Adequate nursery facilities to provide either carp or tilapia fingerlings depending upon the preferred species in the area;
- Incentives for farmers to participate in the form of micro-financing for pond development and for purchase of fingerlings and other inputs.
- Marketing support;
- Development communications support.

Additional incentives may be introduced in the form of a competition for the highest yield of rice and fish at the municipal and provincial levels where substantial cash prizes can be won by the successful farmers.

10.2. Mussel and Oyster Farming

Mussels and oysters enjoy high acceptability in the Philippines. If the sanitation problem can be overcome it also has good export potentials. On the other hand, because they can be produced at very low cost, mussels and oysters can also be viewed as potential feed for high value carnivores such as groupers, lobsters and mud crabs which are easily exportable.

It is estimated that as of 1995 the productive area for oysters was only 228 ha and for mussels 361 ha (BFAR, 1997) or a total of 589 ha. The Philippines has a much large potential than what it presently has. In a pre-investment feasibility study conducted under the auspices of FAO for the Philippine government, Glude et al (1982) estimated that some 9,145 ha are suitable for oyster farming and 4,925 ha for mussel farming. This means only 3.9% of the available area are currently being used for oyster farming 4.6% for mussel farming. Of the potential areas for oyster farming 47.2% or 4,320 ha is found in Region I (Ilocos Region) and 27.3% or 2,500 ha within Region VIII (East Visayas). For mussel farming, a full 83.2% or 4,100 ha can be found within Region VIII also. This means a program to expand the present mussel and oyster production capability of the Philippines need to cover just the two regions and still achieve a high impact. East Visayas incidentally is also one of the relatively economically depressed areas in the Philippines.

Mussel and oyster farming as a livelihood alternative is often left out in Philippine fisheries planning because of the red tide problem. This is a pity because oyster and mussel farming requires very little capital investment, are labor intensive and their operation does not require very high skills. For sure the occurrence of red tide is a serious public health problem due to paralytic shellfish poisoning. However, it does not affect mussel or oyster survival and growth. It only affects their wholesomeness for human consumption and therefore their marketability. Once the red tide bloom disappears it does not take long for the mussels and oysters to become fit for human consumption. With a vigilant red tide monitoring and warning system in place, the red tide hazard can be greatly minimized. In fact red tides may be viewed positively in that during such episodes, the shellfish is allowed to grow and reproduce.

The real problem with red tide therefore lies not on its effect to the production system but to the cash flow of the affected oyster and mussel growers. During a red tide episode the growers, unable to market their produce will loss a ready source of cash for their daily needs. Additionally, it is not possible to predict how long a red tide bloom will persist. It can last for just a few days or could extend for several weeks. Mussel or oyster farming therefore should be introduced as a form of supplementary rather than the only means of livelihood. As a supplementary livelihood its main purpose will be for poverty alleviation rather than food security. Once in place, it shall of course also become a valuable source of animal protein. In this manner, the growers can then afford to wait for the red tide to pass.

Key to the success of any aquaculture project is the marketability of the produce. Glude et al (1982) identified three constraints to the marketing of oysters and mussels: wholesomeness of the product, unpredictable availability, and inadequate system for transporting them to market centers. If these constraints can be addressed demand can be increased and production will increase correspondingly in response to the demand.

To ensure product wholesomeness and protection of public health the proposed project should include the following components as proposed by Glude et al:

- A National Shellfish Sanitation and Health Program which will approve areas where oysters and mussels can be harvested and marketed without any further treatment but which will also prohibit the marketing of the shellfish harvested from contaminated waters unless these are cleansed following established procedures;
- A "natural cleansing station" where oysters and mussels from contaminated areas can be brought for cleansing using naturally-clean seawater prior to marketing;
- A pilot Shellfish Depuration Plant; and
- A pilot-scale Shellfish Processing Plant located in an area with substantial production or high potential for production.

To increase demand the following actions recommended by Glude et al in 1982 are still valid:

- Ensure the availability of clean, safe products;
- Develop better systems for packing and shipping to improve product quality;
- Improve product forms to reduce shipping costs;
- Ensure continuity of supply.

The fallback position if the market for direct human consumption cannot be expanded is to make the product available as feed for raising high value carnivores. This should be resorted to only in case of product glut.

10.3. Mangrove Pen Culture

The viability of raising mudcrabs in a pen enclosure set within a mangrove forest without cutting down a single tree has been adequately demonstrated by SEAFDEC AQD in several sites in the Philippines. Bamboo pens lined with coarse-mesh nets topped by a plastic sheet all around to prevent the crabs from escaping are installed between the trees. Shallow ditches are dug to provide refuge to the crabs during low tide.

Crabs are stocked at the rate of one crab per square meter. Feed consists of fish with low market value and/or the golden snail which have become a pest. Undersize tilapia proliferating wildly in brackishwater ponds and is not used for direct human consumption also makes good feed. One hectare of such pen can produce as much as 1,400 kg of crabs which could mean a gross sales of about PHP280,000. The technology for producing mud crab seedstock is ready for dissemination and commercialization.

Even with most of the mangrove forests already gone due to large-scale fishpond development in the past, enough still remain along the fringes of the sea and along tidal rivers for such a project. Again like that for the rice and fish project this will require the provision of the same support services, training, provision of seedstock and financing.

10.4. Mariculture Park

Coastal or municipal fisheries in the Philippines has reached the point of diminishing returns. More and more fishers are chasing after less and less fish. There is a need to reduce fishing pressure to allow the fish resources to recover. This can be done only by encouraging fisherfolks to shift to other means of livelihood. Aquaculture, specifically sea-based aquaculture, beckons as one such alternative. The culture of fish or other marine organisms in the sea will mean giving fisherfolks a livelihood involving the production of the very same commodity, and in the very same environment, they are already familiar with. It can be considered a most logical choice.

The productivity of sea cages, particularly those set in deeper waters has already been adequately demonstrated by the few pioneering individuals. Properly regulated as is done in other countries, and with a judicious choice of species, it can be made sustainable. Candidate species for such a venture are milkfish, siganids or rabbitfish and saline-tolerant tilapia. Carnivore species such as seabass, *Lates calcarifer*, or for groupers, *Epinephelus* spp. should not be excluded. In areas where there is a possibility of producing tilapia biomass cheaply using only fertilizers or where there is a seasonal excess of sea-catch, these species may be included.

Milkfish is now the species being cultured in the pioneering sea cages. A circular cage with a diameter of 19 m and a netcage depth of 15 m set in waters 30 m deep was found to be capable of producing from 30 to 60 mt of milkfish. What more the milkfish produced, with an ABW of 0.5 kg are larger than those produced in land-based ponds within the same culture period of 120 to 150 days. Being reared purely on artificial diet in oceanic waters it also has no chance to develop off-flavor and can therefore command a better price. Milkfish diets are formulated with only 25% crude protein most of which are derived from terrestrial plants, mainly soybeans. Only 10.8% of the feed is fishmeal. (Feed Development Section, 1994)

Siganids are herbivores. They have long been cultured in brackishwater ponds and cages in the province of Pangasinan. Their culture in cages have also spread to the provinces of Misamis Ocidental and Negros Oriental. They can be fed with Gracilaria or Eucheuma which are easily grown with minimal costs. In Pangasinan scrap vegetables from the market is reportedly also used as feed and in Bais, Negros Oriental kangkong or swamp cabbage, *Ipomeia aquatica*. SEAFDEC AQD is now verifying the culture of siganids in marine cages in their Igang Station in Guimaras Island, Iloilo. The trial runs are still on-going but the results thus far have been encouraging and the culture economics and viability should be determined once the trials are completed.

Saline-tolerant tilapia, mainly *O. mossambicus* hybrids, have been tested in marine cages and have shown encouraging results. Tilapia diet is not much different from milkfish diet. Only it requires more fish meal (18.25%) than milkfish diet.(Feed Development Section, 1994). Both milkfish and tilapia diet are already commercially available and well distributed throughout the country.

The biggest problem in promoting sea cages as a technology option for the poor is the cost of the cages and their installation. The 19 m diameter imported fish cages reportedly cost more than PHP1.4 million (approximately US$36,800) installed with 50% of the cost apparently going into its mooring system. A locally manufactured circular cage with 15 m diameter reportedly cost about PHP600,000 (=US$15,789) installed. Smaller cages for less exposed sites are available at about PHP100,000 (=US$2,632) per 4-cage module, with each cage measuring 5 x 5 m, without the mooring.

The quality and design of the mooring system is important to ensure that the cages will be able to resist stronger than normal wind and wave action. If a mooring system can be provided as an infrastructure for mariculture in the same manner that fishing ports are provided for capture fisheries with fishing boats merely paying for mooring fee depending upon the size of the craft, the cost of installing sea cages can be greatly reduced.

The concept of a mariculture park envisions that the government provides the infrastructure for mariculture in the same manner that it provides farm to market roads, irrigation system and post harvest storage facilities for agriculture. Such facilities can even be constructed by the private sector using Build-Operate-Transfer (BOT) schemes already being employed in the building of roads and power plants. Marine engineers can design such mooring systems in a given area to a given specification. Plastic buoys can be used to maintain the mooring terminals at the water surface. Prospective fish cage operators will merely have to shackle their cages to the mooring point and pay a corresponding mooring fee based on the size of the cages. The fees can be based on a fair return on the investment for the infrastructure amortized over a period of 20 to 25 years just like roads and bridges.

In the Philippines such a mariculture park already has a legal framework. The Fisheries Code of 1998 requires that aquaculture areas be designated by local governments in case of municipal waters or by the Department of Agriculture for waters located outside municipal waters. Furthermore the appropriate government unit is also required to regulate the stocking density and feeding based on the carrying capacity of an area.

The development of a mariculture park is the best way for LGUs or the national government to implement the said provisions of the law. Without such an infrastructure, mariculture development will be difficult to monitor and regulate and cages will be installed anywhere based purely on market forces without any order to ensure sustainability. In a mariculture park the government can regulate the number and sizes of cages. The distances between cages will be pre-determined by the location of the mooring buoys. Regulating the number of cages is one way of regulating stocking and feeding. Floating wave breakers can be installed to soften the impact of wave action and reduce the risk of damage.

Appropriate sites should be identified based on relative exposure to heavy winds, frequency of typhoons, current direction and proximity to sensitive ecosystem such as a coral reef, as well as navigation. Appropriate policies can be developed as to access to capture fisheries within the mariculture park area. For a start a pilot mariculture park should immediately be designed and installed to determine technical and financial viability. Once found viable this can be scaled up and replicated in other similar areas.

Social preparations shall be required for the target beneficiaries, namely the impoverished fisherfolk. Mariculture will alter their pattern of livelihood. In fishing, the cash inflow is as often as their frequency of going out to sea. In mariculture, cash inflow is realized only after the stock is harvested which could take from four to six months depending upon the species. It is expected that during the first cycle of operations some amount of fishing will still be necessary in order for them to sustain their families.

Technical training on net-cage maintenance, stocking, feeding, size monitoring, harvesting should also be provided. Support services in the form of credit, extension service, cold storage and market linkage will be essential.

Aquaculture is the only way for fisheries production to grow with the population. The vast expanse of the sea remains as the only frontier for aquaculture development. It will be through pro-active acts such as the establishment of mariculture parks that development can proceed in an orderly, sustainable, and equitable manner.

REFERENCES

ADB, 1989. Project Performance Audit Report, Laguna de Bay Fish Pen Development Project in the Philippines. Asian Development Bank, Manila, Philippines, December 1989

Ahmed, M, MAP Bimbao and RC Sevilleja, 1992. The economiucs of rice-fish in Asian mixed farming system - a case study of the Philippines. *In*: CR dela Cruz, C. Lightfoot, BA Costa Pierce, VR Carangal and MP Bimbao (eds) Rice-fish research and development in Asia. ICLARM Conf. Proc. 24, p 207-216

Alferez, VN, 1977. Engineering aspects and problems in the design and construction of fishpens and fish cages in Laguna Lake, Philippines. *In:* Proceedings of the Joint SCSP/SEAFDEC Workshop on Aquaculture Engineering, Vol. 2, Technical Report, South China Sea Fisheries Development and Coordinating Programme, Manila, Philippines, SCS/GEN/77/15, December 1977.

Aypa, SM, 1992. Fishery techniques appropriate for rural areas. *In*: Proceedings of the Workshop on Appropriate Applied Mariculture and Rural Fisheries, 15-22 October 1988, (Calumpang, HP, ML Dolar, JS Estacion and RO de Leon, eds), Siliman University Press, Dumaguete City, Philippines pp. 173-197

Baliao, D and M delos Santos, 1998. Mudcrab pen culture in mangroves. Lecture notes, Training on Coastal Fisheries Resources Management, Sept. 1998, SEAFDEC Aquaculture Department, Tigbauan, Iloilo, Philippines.

BAS, 1995. Fishery Statistics 1985-1994. Dept. of Agriculture, Bureau of Agricultural Statistics, Quezon City, Philippines, September 14, 1995.

BAS, 1997. Fisheries Statistics of the Philippines, 1992-1996. Department of Agriculture, Bureau of Agricultural Statistics, Quezon City, Philippines.

Bellena, AP, 1998. Banks slammed for bias against lending to farmers, fisherfolk. *In: CyberDyaryo,* Web-based newsletter of Countrywide Development Wide Area Network (CodeWAN) Nov. 11, 1998 (http://www.codewan.com.ph)

Beveridge, MCM, 1984. Cage and pen fish farming. Carrying capacity models and environmental impact. FAO Fish. Tech. Pap. (255):131 p.

Bimbao, MP, AV Cruz and IR Smith, 1990. An economic assessment of rice-fish culture in the Philippines. *In*: Hirano, R. and I Hanyo (eds) Proc. of the Second Asian Fisheries Forum Asian Fisheries Society, Manila Philippines

BFAR, 1981 up to 1994. BFAR Annual Reports. Department of Agriculture, Bureau of Fisheries and Aquatic Resources, Quezon City, Philippines.

BFAR, 1987. Integrated Livelihood Program for Fisherfolk. Department of Agriculture, Bureau of Fisheries and Aquatic Resources, Quezon City, Philippines, February 1997.

BFAR, 1998. 1997 Philippine Fisheries Profile. Bureau of Fisheries and Aquatic Resources, Quezon City, Philippines

BFAR, 1998. Agrikulturang MAKAMASA Fisheries. Department of Agriculture, Bureau of Fisheries and Aquatic Resources, Quezon City, Philippines. October 26, 1998

CMS, 1997. Microfinance: Frequently Asked Questions. Coalition for Microfinance Standards Sept. 23, 1997 In: Countrywide Development Wide Area Network (CodeWAN) (http://www.codewan.com.ph)

Constantino-David, K, 1997. A history of Philippine NGOs *In:* Silliman SG. and L Noble (eds) Non-Governmental Organizations in the Philippines: Civil Society and the State. University of Hawaii Press, Honolulu, Hawaii

Cruz, PS, 1998. Prospects of milkfish sea cage farming. SEAFDEC Asian Aquaculture. Oct. 1998, 20(5):14-16

Cuyugan, T, 1998. NGOs regulate themselves. In: CyberDyaryo Oct. 29, 1998 On-line newsletter in CodeWAN (http://www.codewan.com.ph)

de Castro TR and NG Guanzon, Jr, 1993. Growth of *Gracilaria* sp. (Gracilariales, Rhodophyta) in brackishwater ponds at different stocking densities. The Israeli Journal of Aquaculture - Bamidgeh 45:89-94

dela Cruz, CR, 1982. Fishpen and Cage Culture Development Project in Laguna de Bay, Philippines. SCS/82/WP/102 South China Sea Fisheries Development and Coordinating Programme, Manila, Philippines, June 1982

dela Vega, A, 1998. Milkfish farming in marine pens and cages. SEAFDEC Asian Aquaculture, Oct. 1998, 20(5):26-28

Delmendo, MN and RH Gedney, 1974. Fish Farming in Pens: A New Fishery Business in Laguna de Bay. Technical Paper No. 2, Laguna Lake Development Authority, Pasig, Metro Manila, Philippines

Domingo FY and RN Visitacion, 1998. Tilapia Water Introduction on Prawn System (TIPS). Paper presented during the National Prawn Industry Congress, October 27 to 29, 1998 Amigo Terrace Hotel, Iloilo City, Philippines

Dureza LA, CC Gempis, RC Salvador, RP Sombrero and BD Belmonte, 1994. Effects of selected factors in teh growth and survival of tilapia hybrids raised in cages in saline water. *In*: Tilapia Farming: Genetic Improvement and Advances in Culture Technology. Proceedings of the 3rd Nat. Symposium and Workshop on Tilapia Farming, 25-27 November 1993. Univ. of the Philippines in the Visayas, Iloilo City.

Echols, JM and H. Shadily, 1989. Kamus Indonesia-Inggris, An Indonesian-English Dictionary. Third Edition (revised by JU Wolf and JT Colins in cooperation with H. Shadily), PT Gramedia Press, Jakarta, Indonesia

Edwards, P and H Demaine, 1997. Rural aquaculture: Overview and framework for country reviews. RAP Publication 1997/36. Regional Office for Asia and the Pacific, Food and Agriculture Organization of the United Nations, Bangkok, Thailand.

Eknath, AE, 1994. The project of Genetic Improvement of Farmed Tilapias (GIFT): from modest beginnings to an international network on genetics in aquaculture. *In*: Tilapia Farming: Genetic Improvement and Advances in Culture Technology. Proceedings of the 3rd Nat. Symposium and Workshop on Tilapia Farming, 25-27 November 1993. Univ. of the Philippines in the Visayas, Iloilo City.

English, LJ, 1986 Tagalog-English Dictionary, National Bookstore, Inc., Manila, Philippines

Feed Development Section, 1994. Feeds and feeding of milkfish, Nile tilapia, sea bass and tiger shrimp. Aquaculture Extension Manual No. 21. SEAFDEC Aquaculture Department, Tigbauan, Iloilo, Philippines.

Fernandez, PM. 1995. Status of fisheries education in the Philippines. Paper presented at the Sectoral Workshop Towards Improvement and Growth of the Fisheries Industry, BFAR/DA-ADB-FAO-UNDP. Sulo Hotel, Quezon City, Philippines, 22-23 November 1995

FRMP, undated. Fisheries Resource Management Project. Pamphlet produced by FRMP, Department of Agriculture, Bureau of Fisheries and Aquatic Resources, Quezon City, Philippines.

Glude, JB, MA Steinberg and RC Stevens, 1982. The feasibility of oyster and mussel farming by municipal fishermen in the Philippines. SCS/82/WP/103 Seafarming-Philippines Technical Report, TCP/PHI/8907 (1), Food and Agriculture Organization of the United Nations, South China Sea Fisheries Development and coordinating Programme, Manila, Philippines, July 1982, 48 p.

Gonzales, ER, 1984. Small-scale tilapia cage technology adopted in fishing villages in Laguna Lake, Philippines. Aquaculture, 41 (1984): 161-169

Guanzon NG, Jr. and TR de Castro, 1992. The effects of different stocking densities and some abiotic factors on cage culture of *Gracilaria* sp. (Gracilariales, Rhodophyta). Botanica Marina 35:239-243

Guerrero, LA and RG Cornejo, 1994. Hatchery, nursery and grow-out techniques for hybrid tilapias in brackishwater ponds. *In*: Tilapia Farming: Genetic Improvement and Advances in Culture Technology. Proceedings of the 3rd Nat. Symposium and Workshop on Tilapia Farming, 25-27 November 1993. Univ. of the Philippines in the Visayas, Iloilo City.

Hanisak, MD 1998. Seaweed cultivation: global trends. World Aquqculture, Dec. 1998 (29:18-21)

Herre, AW and J Mendoza, 1929. Bangos culture in the Philippine Islands. Philippine Journal of Science, 38(4):451-509

Hurtado-Ponce, AQ, 1992. Cage culture of *Kappaphycus alvarezii* var. *tambalang* (Gigantinales Rodophyceae). J. Appl. Phycol. 4 (4):311-313

Hurtado-Ponce, AQ, GPB Samonte, MR Luhan, and N Guanzon Jr, 1992. Gracilaria (Rhodophyta) farming in Panay, Western Visayas, Philippines. Aquaculture, 105 (1992):233-240

Hurtado-Ponce, AQ, 1996. Economics of cultivating *Kappaphycus alvarezii* using fixed-bottom line and hanging-long line methods in Panagatan Cays, Caluya, Antique, Philippines. J. Appl. Phycol. 105:105-109

Hurtado-Ponce, AQ and HB Pondevida, 1997. The interactive effect of some environmental factorson the growth, agar yield and quality of *Gracilariopsis nailinae* (Zhang et Xia) cultured in tanks. Botanica Marina 40:217-223

IIRR and SMISLE, 1998. Livelihood options for coastal communities, Volume II.. International Institute for Rural Reconstruction, Silang Cavite and Small Island Agricultural Support Services Programne, Cebu City, Philippines.

Kraft, NWS, 1998. Overview and prospects of credit assistance for the prawn industry. Paper presented during the National Prawn Industry Congress, Amigo Terrace Hotel, Iloilo City, Philippines, October 27-29, 1998.

Kraft, NWS, 1999. The Agro-Industry Modernization Credit and Financing Program (AMCFP). Presentation during the Fisheries Planning and Budget Consultation Workshop, CY1999-2000, Anne Racquel's Mountain Resort, New Cabalan, Olongapo City, Philippines, January 26 to 29, 1999

Librero, AR, ES Nicolas, AL Banasihan, RM Fabro, LP Lapie, AM Nazareno, and EO Vazquez, 1977. Milkfish farming in the Philippines: a socio-economic study. SEAFDEC-PCARR Research Program, Los Baños, Laguna, August 1977.

Loco, S, 1994. The tilapia industry and the management of Lake Sebu. *In*: Tilapia Farming: Genetic Improvement and Advances in Culture Technology. Proceedings of the 3rd Nat. Symposium and Workshop on Tilapia Farming, 25-27 November 1993. Univ. of the Philippines in the Visayas, Iloilo City.

Mair GC, JS Abucay, JP Capili, LR Dahilig, RC Sevilleja and JA Beardmore, 1994. The development of YY-male technology for the production of monosex tilapia in the Philippines. *In*: Tilapia Farming: Genetic Improvement and Advances in Culture Technology. Proceedings of the 3rd Nat. Symposium and Workshop on Tilapia Farming, 25-27 November 1993. Univ. of the Philippines in the Visayas, Iloilo City.

Medina FM, 1984. Securing the small fisherman's lot on the waters of Laguna de Bay. Bondline (28)1:28-32

Misagal AE, 1986. Recommended design for fishpens and fishcages under the Laguna de Bay Fishpen Development Project of the Laguna Lake Development Authority. In: Report of the National Consultative

Meeting on Aquaculture Engineering, 2-5 Oct. 1985, SEAFDEC/AQD, Tigbauan, Iloilo. ASEAN/UNDP/FAO Regional Small-Scale Coastal Fisheries Development Project, Manila Philippines, October 1986.

Morales AC and JE Padilla, 1998. Economics of fishpen and fishcage operations in Lingayen Gulf, Philippines. Draft report prepared by the Environmental and Natural Resources Accounting Project (ENRAP) of the Dept. of Environment and Natural Resources (DENR) for the Lingayen Gulf Coastal Area Management Commission. Quezon City, Philippines, Nov. 5, 1998.

NSCB, 1998. 1998 Philippine Statistical Yearbook. National Statistical Coordination Board, Makati City, Philippines, October 1998

NPPMCI, 1998. Is CARP the answer? Editorial in Coop Link, Newsletter of the Negros Prawn Producers Marketing Cooperative, Inc. April to June, 1998. Bacolod City, Philippines

PBSP, 1998. Centennial Annual Report. The Philippine Business for Social Progress 1998 Annual Report. PBSP, Real corner Magallanes Sts, Intramuros, Manila, Philippines

PCAMRD, 1996. An analysis of the R & D investment in the fisheries sector. Phil. Council for Aquatic and Marine Research and Development, Los Baños, Laguna, Philippines

Posadas, BC, 1988. An economic and social analysis of the seaweeds industry in selected areas in the Philippines, Asian Fisheries Social Science Research Network Research Report, University of the Philippines in the Visayas, Iloilo City, Philippines, May 1988.

PRIMEX-ANZDEC, 1996. Fisheries Sector Development Project. ADB-TA 2236-PHI Draft Final Report. Dept of Agriculture, Fisheries Sector Program, 2nd Floor. Estuar Building, 880 Quezon Ave., Quezon City, Philippines

Rabanal, HR, 1995. Aquaculture extension services review: the Philippines. FAO Fisheries Circular No. 892. Food And Agriculture Organization of the United Nations, Rome, June 1995.

Rebong, N, 1997. CMS unveils project to alleviate poverty of millions of Filipinos. *In:* CyberDyaryo, Web-based newsletter of Countrywide Development Wide Area Network (CodeWAN) July. 2, 1997 (http://www.codewan.com.ph)

Republic of the Philippines, 1988. Comprehensive Agrarian Reform Law of 1988. Republic Act 6657, June 10, 1988

Republic of the Philippines, 1990. The Cooperative Code of the Philippines. Republic Act 6938, March 10, 1990

Republic of the Philippines, 1991. Local Government Code of 1991. Republic Act 7160. October 10, 1991

Republic of the Philippines, 1997. Agricultural and Fisheries Modernization Act. Republic Act No. 8435

Republic of the Philippines, 1998. Philippine Fisheries Code of 1998. Republic Act 8550, February 25, 1998

Reyes, CC, WL Griffin, and JT Davis, 1982. Survey of freshwater aquaculture production in Central Luzon, Philippines. DIR 82-1, SP-8, Departmental Information Report, Staff Paper Series, Texas Agric. Expt. Station, Texas A&M Univ., College Station, Texas September 1982.

Rice, MA and AZ DeVera, 1998. Aquaculture in Dagupan City, Philippines. World Aquaculture, March 1998, 29 (1):18-24.

Rodriguez, B Jr, 1998. Research project evolves into a foundation. NAGA, The Iclarm Quarterly 21(4): 53-54, Oct.- Dec., 1998.

Ronquillo, IA, 1992. The fishery resources in the Philippines and its relation to mariculture development. *In*: Proceedings of the Workshop on Appropriate Applied Mariculture and Rural Fisheries, 15-22 October 1988, (Calumpang, HP, ML Dolar, JS Estacion and RO de Leon, eds) Siliman University Press, Dumaguete City, Philippines, pp 93-103

Rosell NC. 1992. The green mussel (*Perna viridis*) in the Philippines. *In*: Proceedings of the Workshop on Appropriate Applied Mariculture and Rural Fisheries, 15-22 October 1988, (Calumpang, HP, ML Dolar, JS Estacion and RO de Leon, eds) Siliman University Press, Dumaguete City, Philippines, pp. 297-305

Rosell NC. 1992. The slipper-shaped oyster (*Crassostrea iredalei*) in the Philippines. *In*: Proceedings of the Workshop on Appropriate Applied Mariculture and Rural Fisheries, 15-22 October 1988, (Calumpang, HP, ML Dolar, JS Estacion and RO de Leon, eds), Siliman University Press, Dumaguete City, Philippines, pp 307-313

Samonte, GPB and RS Ortega, 1992. A survey of small-scale fishermen's credit practices in Panay, Philippines. Phil. Quarterly of Culture and Society 20(1992):300-316

Samonte, GPB, SV Siar, RS Ortega, and LT Espada, 1994. Socio-economics of oyster and mussel farming in Western Visayas, Philippines. *In*: The Third Asian Fisheries Forum (Chou, LM, AD Munro, TJ Lam, TW Chen, LKK Cheong, JK Ding, KK Hooi, HW Khoo VPE Phang, KF Shim and CH Tan, eds). Asian Fisheries Society, Manila, Philippines.

Sanchez, M, 1997. Gov't drive vs illegal fishpens gets P5m boost. Article in the Manila Chronicle, Dec. 18, 1997, p. 6

Santiago, AE and RP Arcilla, 1993. Tilapia cage culture and the dissolved oxygen trends in Sampaloc Lake, the Philippines. Environmental Monitoring and Assessment 24:243-255

Sevilleja, RC, 1992. Rice-fish Farming develop0ment in the Philippines: psat, present and future. *In:* Dela CruzCR, C lightfoot, BA Costa-Pierce, VR Carangal and MAP Bimbao, (eds) 1992. Rice-Fish Research and

Development in Asia. International Center for Living Aquatic Resources Management, Metro Manilla, Philippines.
Siar SV, GPB Samonte and AT Espada, 1995. Participation of women in oyster and mussel farming in Western Visayas, Philippines. Aquaculture Research, 1995, 26:459-467
Tan RL, LTP Baskiñas and PG Garcia, 1994. Socio-economic profiling and analysis of fishcage culture and capture fisheries in Taal Lake. Report to Phil. Council for Aquatic and Marine Research and Development (PCAMRD), DOST.
Triño, A and E. Rodrigues, 1999. Mud crab culture in tidal flats with existing mangroves. Paper presented at the Workshop on Mangrove-Friendly Aquaculture, Iloilo City, Philippines Jan. 11-15, 1999.
Trono, GC Jr, 1988. Manual on Seaweed Culture, 2. Pond culture of *Caulerpa* and 3. Pond culture *Gracilaria*, ASEAN/SF/88/Manual No. 3, ASEAN/UNDP/FAO Regional Small-Scale Coastal Fisheries Development Project, Manila, Philippines, Dec. 1988.
UPLB Foundation, Inc., 1996. Rapid Resource Appraisal of Taal Lake. Terminal Report to the Dept. of Agriculture, Bureau of Fisheries and Aquatic Resources, Fisheries Sector Program. UPLB Foundation, Inc., College, Laguna, Philippines
Velasco, MT, 1997. Dismantling of Lingayen illegal fishpens on. Article in the Manila Bulletin, Nov. 19. 1997, p. 26.
Villadolid, DV and DK Villaluz. 1951. The cultivation of sugpo (*Peanaeus monodon* Fabricius) in the Philippines. Phil. J. Fish. 1:55-65
Villaluz, DK. 1953. Fish Farming in the Philippines. Bookman, Manila
Yap, WG, 1978. Settlement preference of the brown mussel, *Modiolus metcalfei* Hanley and its implication on the aquaculture potential of the species. Fisheries Research Journal of the Philippines, 3(1):65-70.
Yap, WG, 1997. Can the Philippines produce enough fish for the multitude? Aquaculture Asia, July-September 1997, 2(3):32-38
Zafarella, MT, 1994. The dwindling fish productivity of Laguna de Bay in relationship with water quality and primary productivity. Technical Report No. 3, Laguna de Bay Economic Valuation Study. Policy Development Foundation, Inc (PDFI), Pasig Metro Manila; and Resouerces, Environment and Economic Consultants, Inc. UP Diliman, Quezon City, Philippines, May 31, 1994.

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Table 1. Physical features of the Philippines

A Land Resources			
	1. Number of Islands		7,100
	2. Total Land Area		299,735 km^2
	3. Percent Agricultural		34%
	4. Length of Coastline		17,460 km
B. Marine Resources			
	1. Total Territorial Water (including EEZ)		2,200,000 km^2
		a. Coastal	266,000 km^2
		b. Oceanic	1,934,000 km^2
	2. Shelf Area (Within 200 m depth)		184,600 km^2
	3. Coral Reef Area		27,000 km^2
C. Inland Water Bodies			
	1. Swamplands		3,384 km^2
		a. Freshwater	1,063 km^2
		b. Brackishwater	2,321 km^2
	2. Existing Fishponds (whether in use or idle)		2,538 km^2
		a. Freshwater	145 km^2
		b. Brackishwater	2,393 km^2
	3. Other Bodies		2,500 km^2
		a. Lakes	2,000 km^2
		b. Rivers	310 km^2
		c. Reservoirs	190 km^2

(SOURCE: BFAR, 1997 Phil. Fisheries Profile; NSCB, 1998 Phil. Statistical Yearbook)

Table 2. Selected economic indicators, Philippines, 1994 and 1997,

Economic Accounts		**1997**	**% Change from 1996**
Gross National Product (in million PHP at current prices)		2,526,891	11.7
Gross National Product (in million PHP at constant 1985 prices)		931,118	5.3
Real Per Capita GNP (in PHP at constant 1985 prices)		12,663	2.9
Gross Domestic Product (in million PHP at constant 1985 prices)		893,017	5.2
Gross Value Added (in million PHP at constant 1985 prices)			
	Agriculture, Forestry and Fishery	184,713	2.9
	Industry	320,689	6.1
	Service	387,615	5.5
Income Statistics		**1997**	**1994**
Average Annual Income (PHP)		123,881	83,161
Average Annual Expenditure (PHP)		100,194	67,661
Poverty Threshold (Annual per Capita in PHP)		11,388	8,885
Food (Subsistence) Threshold (Annual Per Capita in PHP)		7,724	6,022
Poverty Incidence (% of total families)		32.1%	35.5%
Subsistence Incidence (% of total families)		16.5%	18.1%

(Source: NSCB, 1998 Phil. Statistical Yearbook; NSCB Homepage, http://www.nscb.gov.ph/)

Table 3. Contribution of Fisheries to GVA in Agriculture, Fishery and Forestry, 1997.

	At Current Prices		At Constant 1985 Prices		
	Amount (M PHP)	**% of GVA in Agri. Sector**	**Amount (M PHP)**	**% of GVA in Agri. Sector**	**% Growth from 1996**
Grains, coconut, sugarcane, & other crops	263,560	58.2	99,973	54.1	4.67
Livestock	61,368	13.6	22,273	12.1	5.34
Poultry	36,194	8.0	19,088	10.3	6.83
Agric. activities & services	20,907	4.6	7,992	4.3	1.96
Fishery	67,776	15.0	34,275	18.5	-0.04
Forestry	2,741	0.6	1,112	0.6	-41.41
TOTAL	**452,546**	**100.0**	**184,713**	**100.0**	**2.94**

SOURCE: NSCB, 1998 Philippine Statistical Yearbook

Table 4. Export and import of fishery products, Philippines, 1997

	Quantity(mt)	**FOB Value**	
		PHP (million)	**USD (million)**
Fishery Exports	173,887	16,337	549.8
Fishery Imports	295,015	4,020	138.1
Balance of Trade	(121,129)	12,317	411.7

(Source: 1997 Philippine Fisheries Profile, BFAR)

Table 5. Labor force employed in the fisheries industry, Philippines

Classification	**No of Persons**
Aquaculture	258,480[a]
Municipal	675,677[b]
Commercial	56,715[a]
Total	990,872

a) 1987 Fisheries Statistics, BFAR b) 1980 Fisheries Census, NSO

Table 6. Species cultured in the Philippines and extent of commercialization

Species	Hatchery	Source of Seedstock	Grow-out	Extent Commercialized
FISH				
Milkfish · *Chanos chanos*	Developed	Mainly wild-caught plus hatchery	Extensive to intensive Brackishwater ponds Freshwater pens/cages Marine pens/cages Deepwater cages	Grow-out industry highly developed but as of 1998 only one commercial hatchery Commercial feeds readily available
Tilapia · *Oreochromis niloticus* · *O. mossambicus*	Developed, already into genetic manipulation	Hatchery SRT, GMT, GIFT, Saline Hybrids	Extensive to intensive Freshwater ponds Brackishwater ponds Freshwater pens/cages Concrete tank systems	Both hatchery and grow-out industry highly developed Commercial feeds readily available
Carps · *Cyprinus carpio* · *Aristhichthys nobilis* ·(others)	Developed	Hatchery	Extensive to semi-intensive Freshwater ponds/cages/pens	Limited and not widespread Few private hatcheries mostly government.
Catfish · *Clarias batrachus* · *C. gariepinus*	Developed *C. macrocephalus* still under R & D	Hatchery	Semi-intensive Freshwater ponds Some pens and cages	Limited, mostly small-scale, but more widespread than carps
Mudfish or snakehead · *Ophicephalus striatus*	Developed but not yet commercial	Wild-caught	Freshwater ponds Some cages	Very limited, mainly as secondary species
Gourami · *Osphronemus gouramy*	No commercial hatchery	Natural spawns	Extensive Freshwater fishpond	Limited market
Seabass · *Lates calcarifer*	Developed	Hatchery	Extensive to semi intensive Brackishwater ponds	Growth limited by low price and high production cost.
Grouper · *Epinephelus* spp.	R & D stage	Wild-caught	Extensive to semi intensive Brackishwater ponds Marine cages	Grow-out limited only by supply of fingerlings Commercial feed available 1998
Rabbitfish · *Siganus* guttatus · *Siganus vermiculatus*	Developed but not commercialized	Wild-caught	Brackishwater ponds Marine pens/cages	Limited development; no steady market demand for fingerlings
Spadefish · *Scatophagus argos*	No work done even at R & D	Wild-caught	Brackishwater ponds Marine pens/cages	Limited development

CRUSTACEANS				
Jumbo tiger shrimp · *Penaeus monodon*	Developed	Hatchery	Extensive to intensive Polyculture w/milkfish Brackishwater ponds	Intensive farms in process of consolidation after production setbacks
Other penaeids · *P. indicus* · *P. merguiensis* · *Metapenaeus ensis*	Developed but not financially viable	Wild-caught	Extensive. Polyculture with milkfish Brackishwater ponds	Growth limited by seasonality of wild fry and high cost of fry produced in hatcheries
Mud crab · *Scylla serrata* · *Scylla oceanica*	R & D stage under verification	Wild-caught	Extensive to semi-intensive Brackishwater ponds	Growth limited by uncertainty of seedstock supply
Giant Freshwater Prawn · *Macrobrachium rosenbergii*	Government hatchery only	Hatchery	Extensive Freshwater ponds	Grow-out technology in dissemination stage
Lobsters · *Panulirus* spp · Fam. Scyllaridae	None	Wild-caught	Marine pens	Fattening
MOLLUSKS				
Oysters · *Crassostrea iredalei* · *Saccostrea spp.*	R & D	Natural spatfall	Stakes Lines suspended from fixed racks or floating rafts	Widespread small-scale cultures Red tide a constraint
Green mussel · *Perna viridis*	R & D	Natural spatfall	Stakes Raft Buoy and long-line	Practiced in all areas with spawning stock Suffers form periodic red tide
Abalone · *Haliotis asinina* · *Haliotis* sp.(ex Taiwan)	R & D for *H. asinina*	Hatchery	R & D stage for *H. asinina* One company in Cebu growing Taiwan species	Not developed for *H. asinina*
SEAWEEDS				
Carageenophytes · *Eucheuma* spp · *Kappaphycus alvarezii*	Seedling bank inR & D stage	Cuttings: ex wild or farm stock	Fixed bottom line, nets Floating lines May be grown in net cages	Highly developed industry
Agarophytes · *Gracilaria* spp. · *Gracilariopsis balinae*	n.a.	Cuttings: ex wild or farm stock	Brackishwater pond Fixed bottom line May be grown in net cages	Widespread but limited
Chorophyceae · *Caulerpa lentillifera*	n.a.	Cuttings: ex wild or farm stock	Brackishwater pond	Mainly in Cebu and some farming in Batangas province

Table 7. Philippine aquaculture production in 1997 (in metric tons), by ecosystem, culture system and species (Source: Bureau of Agricultural Statistics)

		BRACKISH	FRESHWATER			MARINE		
	TOTAL	Pond	Pond	Pens	Cages	Pens	Cages[a]	Others
TOTAL	957,546	199,020	42,793	19,952	42,679	165	32	652,616
FINFISH	259,192	153,700	42,631	19,950	42,679	76	156	-
Milkfish	161,426	147,251	7	14,168				
Tilapia	91,831	5,939	39,005	4,272	42,615			
Carp	1,865		291	1,510	64			
Grouper	654	496				49	109	
Snapper	32					26	6	
Grunt	12	12						
Siganid	43	2				1	40	
Catfish	1,053		1,052				1	
Mudfish	2,144		2,144					
Gourami	132		132					
CRUSTACEANS	45,325	45,320	-	-	-		5	-
P. monodon	40,102	40,102						
Other Penaeids	1,508	1,508						
Mudcrab	3,710	3,710						
Spiny Lobster	5						5	
MOLLUSKS	25,511							25,511
Oysters	13,853							13,853
Mussels	11,658							11,658
SEAWEEDS[b]	627,105							627,105
NOT SPECIFIED	413		162	2		89	160	

[a] Does not include the production of sea cages in the province of Pangasinan where there are about 70 circular cages, each cage capable of producing 30 mt milkfish per 4-5 month cycle because the cages have not yet been included in the BAS statistical frame.

[b] Does not include *Caulerpa* and *Gracilaria* production in brackishwater ponds, probably for the same reason as the sea cages..

Table 8. No. of operators and number of persons employed in aquafarm operation by type of aquafarm, Philippines, 1980. (Source: 1980 Census of Fisheries)

Type of Aquafarm	Total Area Operated (ha)	Total No. Employed	Number of Operators	TOTAL
Fishpond	142,145	124,741	43,757	168,498
Fishpen	5,720	5,414	2,379	7,793
Seaweeds	3,565	16,805	16,477	33,282
Oysters	494	2,646	2,204	4,850
Mussels	244	1,989	1,380	3,369
Frog	2	31	27	58
Others	54	1,948	1,694	3,642
TOTAL	**152,224**	**153,574**	**67,918**	**221,492**

Table 9. Size frequency of a random sample (N=1175) of brackishwater fishponds in the Philippines, whether under Fishpond Lease Agreement (FLA) or privately-owned, by number and by area (based on data from Librero et al, 1977).

Size Class	Number	Per cent by Number	Area (ha)	Average Area (ha)	Per cent by Area
1 ha. and below	178	15.2	110.01	0.62	0.9
1.01 to 5.00 ha	392	33.4	1,109.39	2.83	8.6
5.01 to 10.00 ha	192	16.3	1,457.85	7.59	11.2
10.01 to 20.00 ha	201	17.1	2,926.86	14.56	22.6
20.01 to 50.00 ha	153	13.0	4,768.12	31.16	15.3
More than 50 ha	59	5.0	5,367.07	90.97	41.4
ALL SIZES	1,175	100.0	15,739.30	13.40	100.0

Table 10. Size frequency of brackishwater fishponds in the Philippine under Fishpond Lease Agreement (FLA) by number and by area (based on analysis of BFAR FLA Records as of November 1998).

Size Class	Number	Per cent by Number	Area (ha)	Average Area (ha)	Per cent by Area
1 ha. and below	111	2.4	72.041	0.649	0.1
1.01 to 5.00 ha	2,418	51.5	9,458.368	3.912	15.1
5.01 to 10.00 ha	537	11.4	3,925.285	7.310	6.3
10.01 to 20.00 ha	678	14.4	9,742.785	14.370	15.5
20.01 to 50.00 ha	852	18.2	26,471.038	31.069	42.3
More than 50 ha	98	2.1	12,956.310	132.207	20.7
ALL SIZES	4,694	100.0	62,625.827	13.34168	100.0

Table 11. Number and sizes fishpens in Laguna de Bay registered with the Laguna Lake Development Authority (LLDA) by type of ownership. (Based on 1998 LLDA licensing records)

	Corporations	Cooperatives	Individual	Total
Number	96	24	47	167
Area (ha)	3,750.460	438.590	236.598	4,425.648
Mean (ha)	39.067	18.275	5.034	26.501
Minimum (ha)	5.000	4.950	4.530	4.530
Maximum (ha)	52.340	25.230	7.628	52.340

Table 12. Comparison of capital investments of different types of fishcages in Taal Lake, 1995. (From UPLB Foundation, 1996)

Type of Fish Cage	Cage Size (m × m)	Cost per Cage (PHP)	Unit Cost (PHP/m^2)
Fixed	5 × 10	10,025.00	200.50
	7 × 10	11,245.00	160.00
	8 × 10	11,245.00	140.52
	10 × 10	11,595.00	114.95
	10 × 15	12,143.00	80.95
	12 × 15	13,395.00	74.41
Floating	5 × 10	9,300.00	186.00
	7 × 10	9,300.00	132.85
	8 × 10	9,300.00	116.25
	10 × 10	12,643.00	126.43
	10 × 12	12,843.00	107.02
	12 × 12	16,755.00	116.35
	12 × 14	16,755.00	99.73
	12 × 15	18,315.00	101.75
	18 × 20	2,896.00	80.44
Submerged	10 × 12	12,720.00	106.00

Table 13. Number of fish cages by size type, Taal Lake, July 1995 (from UPLB Foundation, 1996)

Cage Size (m × m)	Area per Unit (m^2)	No. of Units	Per Cent by No (%)	Total Area (m2)	Per Cent by Area (%)
5 × 10	50.0	120	3.8	0.600	1.3
7 × 10	70.0	204	6.5	1.428	3.1
8 × 10	80.0	141	4.5	1.128	2.4
7 × 12	84.0	60	1.9	0.504	1.1
10 × 10	100.0	681	21.7	6.810	14.7
10 × 12	120.0	45	1.4	0.540	1.2
10 × 14	140.0	120	3.8	1.680	3.6
12 × 12	144.0	24	0.8	0.346	0.7
12 × 14	168.0	228	7.3	3.830	8.2
12 × 15	180.0	1,349	43.0	24.282	52.3
14 × 15	210.0	51	1.6	1.071	2.3
18 × 20	360.0	117	3.7	4.212	9.1
ALL CAGES	142.2	3,140	100.0	46.431	100.0

Table 14. Costs and returns analysis of fishcage operations in Taal Lake by stocking density per cycle, 1995 (from UPLB Foundation, 1996)

Size of Cage (m × m)	Stocking Density (No/m^2)	Average Expenses (PHP)	Average Yield (MT)	Ave. Gross Income (PHP)	Ave. Net Income (PHP)	No. of Samples
7 × 10	214	45,552.50	1.50	67,500.00	21,653.33	20
5 × 10	200	59,640.75	1.75	78,750.00	25,370.75	12
8 × 10	188	45,522.50	1.50	67,500.00	15,628.66	14
12 × 14(a)	178	112,455.00	3.17	142,500.00	52,031.67	22
12 × 12	174	108,005.00	2.50	112,500.00	3,011.67	6
10 × 12	167	95,513.20	2.73	122,966.00	23,650.33	8
18 × 20	139	211,460.00	4.83	217,501.20	6,040.00	11

a) As printed in original table but is probably a typographical error, correct size may actually be 12m x 15m.

Table 15 Comparative economics of pen/cage farming by species (in PHP), Lingayen Gulf, Philippines, 1997 (Data culled from various tables in Morales and Padilla, 1998.)

	Milkfish	Grouper	Siganid	Polyculture
No. of Farms in Sample	80	6	5	4
Avg Farm Size (m^2)	1,385	170	160	207
Avg Investment Cost	66,962	13,517	10,768	12,350
Avg Fixed Cost per Cropping	7,629	1,424	1,473	1,944
Avg Variable Costs per Cropping	88,415	36,112	31,285	15,317
Avg. Production per Cropping (kg)	8,875	169	355	Milkfish 148 Siganid 176
Avg Farmgate Prices	61	332	118	
Avg Gross Revenue	195,339	55,886	41,914	24,364
Avg Net Profit	99,037	18,013	8,567	6,514
Avg Culture Period (months)	4.0	6.7	3.9	3.75
Margin for Profit and Risk	4,815	2,841	1,667	694
Imputed Family Labor	590		2,839	2,839
Economic Rent per Unit Area	67.60	89.26	25.38	13.49

Gross Profit = Revenues - Variable Costs

Net Profit = Gross Profit - Fixed Costs

Economic Rent = Net Profit - (Margin for Profit and Risks + Imputed Family Labor)

Table 16. Investment requirements and cost and returns (in PHP per ha per year, US$1=PHP26) of *Kappaphycus* farming in Panagatan Cays, Caluya, Antique, Philippines, 1996 (Summarized and reformatted from Hurtado-Ponce et al, 1996).

	Fixed-bottom	**Hanging Long-line**
Capital Investment	11,260	17,009
Working Capital	7,490	8,455
Total Investment	18,750	25,464
Production, dry (kg)		
First Crop	9,300	7,150
Second and Third Crops	18,600	14,300
Revenues, (@PHP7.50/kg)		
First Crop	69,750	63,625
Second and Third Crops	139,500	107,250
Total Revenues	209,250	170,875
Operating Expenses		
First Crop	7,490	8,455
Second and Third Crops	5,180	5,310
Total Cash Expenses	12,670	13,765
Non-Cash Expenses		
Family Labor, 1st Crop	1,800	1,800
Family Labor, 2nd & 3rd Crop	3,600	3,600
Sub-Total Family Labor	5,400	5,400
Depreciation, 1st Crop	821	1,350
Depreciation, 2nd & 3rd Crop	2,463	4,051
Sub-Total Depreciation	3,284	5,401
Total Non-Cash Expenses	8,684	10,801
Net Income		
First Crop	59,639	52,020
Second and Third Crops	128,257	94,289
Total Net Income	187,896	146,309
Return on Investment (%)	1,002	575
Payback Period	105 to 135 days (after 1st crop)	105 to 135 days (after 1st crop)

Note: Operating expenses for the second and third crop together is lower than that of the first crop alone because seedstock expense is non-recurring.

Table 17. Costs and returns of seaweed production by species and by province/technology, Philippines 1996. (Summarized from the Fisheries Statistics of the Philippines, 1992-1996)

	BOHOL[a]	CEBU[b]		
	Eucheuma	***Eucheuma***	***Gracilaria***	***Caulerpa***
Yield (kg/ha/cycle)[c]	18,716	6,329	2,943	4,522
Price (PHP/kg)[d]	17	17	7	7
Quantity sold (kg/ha/cycle)[e]	3,022	1,055	2,937	4,486
Return (PHP/ha/cycle)	51,374	17,935	20,559	31,402
Costs (PHP/ha/cycle				
Seedlings/Seedstock	6,570	1,956	1,955	418
Other Material Inputs	2,962	2,059	1,083	1,212
Labor	13,644	6,127	11,422	11,890
Other Producion Cost	3,515	929	508	747
Marketing Cost	4,927	1,266	-	-
TOTAL COST	31,618	12,337	14,968	14,267
Net Farm Income (PHP/ha/cycle)[f]	19,756	5,598	5,591	17,135

a) Hanging long-line method
b) Bottom farming
c) Fresh form
d) Wholesale price for *Eucheuma*, farmgate price for *Gracilaria* and *Caulerpa*
e) Dried form for *Eucheuma*, fresh form for *Gracilaria* and *Caulerpa*
f) Net wholesale income for *Eucheuma*, net farm for *Gracilaria* and *Caulerpa*

Table 18. Annualized cost and returns for seaweed farming in Bohol and Cebu, Philippines based on Fisheries Statistics of Philippines, 1992-1996 figures as presented in Table 15. All figures in Philippine Peso per hectare per year.

	BOHOL	CEBU		
	Eucheuma	***Eucheuma***	***Gracilaria***	***Caulerpa***
Revenue	154,122	53,805	102,795	157,010
Production Expenses				
Seedstock	6,570	1,956	1,955	418
Other Material Inputs	8,886	6,177	5,415	6,060
Labor	40,932	18,381	57,110	59,450
Other Production Costs	10,545	2,787	1,524	2,241
Marketing Cost	14,781	3,798	-	-
Total Production Cost	81,714	33,099	66,004	68,169
Net Income	72,408	20,706	36,791	88,841

Note: Three harvests per year were assumed for *Eucheuma* based on Hurtado-Ponce (1996) while five harvests a year were assumed for *Caulerpa* and *Gracilaria* based on Trono (1988). The seedstock expense was assumed to be non-recurring while all other expenses were scaled up corresponding to the number of production cycles assumed.

Table 19. Investment requirements and cost and returns (in PHP per ha per year, US$1=PHP27) of *Gracilaria* farming in ponds and canals Iloilo and Capiz provinces, Panay Island, Philippines, 1990 (Summarized and reformatted from Hurtado-Ponce et al, 1992).

		Pond (Actual)[a]	Pond (Potential)[b]	Canal[c]
Capital Investment				
	Pond Development	10,000	10,000	-
	Drying platform, dugout, etc	4,000	4,000	4,000
Working Capital		2,000	2,000	600
	Total Investment	16,000	16,000	4,600
Production, dry (kg)				
	First Crop	450	900	1,300
	2nd to 8th Crops @315kg/crop	2,205	4,410	6,370
	Total Production (kg dry)	2,655	5,310	7,670
Revenues, (in PHP @PHP7.00/kg)				
	First Crop	3,150	6,300	9,100
	2nd to 8th Crops	15,435	30,870	44,590
	Total Revenues	18,585	37,170	53,690
Operating Expenses				
	First Crop	1,376	1,639	588
	2nd to 8th Crops	8,099	8,407	938
	Total Cash Expenses	9,475	10,046	1,526
Non-Cash Expenses				
	Family Labor, 1st Crop	-	-	1,200
	Family Labor, 2nd to 8th Crop	-	-	8,400
	Sub-Total Family Labor	-	-	9,600
	Depreciation, 1st Crop	350	350	100
	Depreciation, 2nd to 8th Crop	2,450	2,450	700
	Sub-Total Depreciation	2,800	2,800	800
	Total Non-Cash Expenses	2,800	2,800	10,400
Net Income				
	First Crop	1,424	4,311	7,212
	2nd to 8th Crop	4,886	20,013	34,552
	Total Net Income	6,310	24,324	41,764
Return on Investment (%)		39%	152%	908%

a Based on actual survey in Villa and Leganes, Iloilo and Pan-ay, Capiz, 1990
b Potential yield if the ponds were seeded at 400 g/m^2 instead of 200 g/m^2
c Uses existing canal in a fishpond system. No development cost involved.

Table 20. Size frequency of oyster farms by region, Philippines, 1974 (from Librero et al, 1976)

REGION	NUMBER OF FARMS				Average Area per Farm(m^2)
	50 m^2 and Below	51-500 m^2	Above 500 m^2	All Sizes	
I	28	55	16	99	389
II	-	1	5	6	3,678
IV	5	22	21	105	2,214
VI	-	-	10	10	10,800
All Regions	33	78	52	163	
Ave. Area per Farm (m^2)	35	260	7,300	2,460	

Table 21. Starting year of oyster farm operators, Philippines, 1974. (after Librero et al, 1976)

Region	1931-40	1941-50	1951-60	1961-70	1971-74	All Years
I	1	1	6	32	59	99
II				1	5	6
IV	2	1	7	25	13	48
VI				8	2	10
All Regions	3	2	13	66	79	163

Table 22. Other sources of income of oyster farmers (Philippines, 1974 and Western Visayas, 1990) and mussel farmers (Cavite 1974 and Western Visayas, 1990). (From Librero et al, 1976; Siar et al, 1995)

	Oyster Farmers		Mussel Farmers	
	1974	1990	1974	1990
Sources of Income				
Fishing and related activities	77.9	57.6	97.0	80.7
Business/entrepeneurial	6.9	8.7	-	18.1
Farming and related activities	6.9	10.9	-	8.4
Others	8.4	33.7	3.0	18.0

NOTE: Percentages in 1990 figures may add up to more than 100% because of multiple responses.

Table 23. Cost and returns of oyster and mussel farming, Western Visayas, Philippines, 1990 (in PHP, US$1.00 = PHP26.00). (From Samonte et al, 1994)

	Per Farm		**Per 1000 m^2**	
	Oyster Farming (n=70)	**Mussel Farming (n=76)**	**Oyster Farming (n=70)**	**Mussel Farming (n=76)**
Returns	5,985	10,608	4,507	15,154
Costs				
Cash Costs				
Materials	2,853	4,484	2,148	6,406
Hired Labor	364	1,634	274	2,334
Miscellaneous	146	314	110	448
Total	3,363	6,432	2,532	9,188
Non-Cash Costs				
Unpaid owner labor	710	360	535	514
Unpaid family labor	520	300	392	428
Depreciation	436	569	328	813
Total	1,666	1,229	1,255	1,755
Total Costs	5,029	7,661	3,787	10,943
Operating Income	2,622	4,176	1,975	5,966
Net Farm Income	956	2,947	720	4,211

Table 24. Averages of economic indicators for Philippine rice monoculture and rice-fish culture from three case studies (from Bimbao et al, 1990).

Item	**Price per unit (US$)**	**Value/Cost (US$/ha)**[a]	
		Rice Monoculture	**Rice-Fish Culture**
Gross returns	0.18/kg	700.00	799.75
Rice	0.90/kg	700.00	673.75
Fish			126.00
Costs		469.35	505.60
Variable		389.85	426.10
Labor[b]		244.25	248.30
Seeds	0.30/kg	15.00	13.50
Fertilizer		57.50	57.50
Chemicals		73.10	66.20
Fingerlings	0.01/pc		37.50
Screens, plastic bags			3.10
Fixed		79.50	79.50
Interest on loan		11.25	11.25
Land amortization		29.00	29.00
Irrigation fee		21.85	21.85
Others		17.40	17.40
Net returns		230.65	294.15

Table 25. Comparison of fishery production in Laguna de Bay, Philippines before (1968) and after (1973) fishpens were introduced. (From Delmendo and Gedney, 1974)

	1968		**1973**	
Net Fishpen Area (ha)	-		4,802	
Total Fishpen Area (ha)	-		5,762	
Open Water (ha)	90,000		84,237	
	Volume (mt)	**Value (PHP'000)**	**Volume (mt)**	**Value (PHP'000)**
Open Water Catch				
Fish	39,015	58,583	20,723	53,330
Shrimps	27,552	13,776	23,957	14,749
Snails	96,483	4,824	77,560	4,207
Open Water Sub-total	163,050	77,183	122,240	72,286
Fish Only per ha	0.434	0.651	0.246	0.633
All Species per ha	1.812	0.858	1.451	0.858
Fishpen Catch	-	-	19,204	76,815
Avg. Catch per ha	---	---	3.999	15.996
Total Fish Catch	39,105	58,583	39,927	130,145
Avg Fish Catch per ha	0.434	0.651	0.444	1.446
Total Catch All Species	163,050	77,183	141,444	149,101
Avg Catch per ha	1.812	0.858	1.572	1.657

Table 26. Farming records of the SPCMBY Federation on Nile tilapia (*Oreochromis niloticus*) growth in Sampaloc Lake, Philippines with the corresponding fish cage area. (From Santiago and Arcilla, 1993)

Year	**Rearing Period (days)**	**Harvest Size (g)**	**Ave. Daily Inc. (g)**	**Cage Area (ha)**
1980	180-240	200-250	1.09	6
1981	150-180	167-200	1.12	6
1982	360-420	143-167	0.39	10
1983	360-540	143-167	0.35	12
1984	360-420	143-167	0.42	16
1985	360-420	143-167	0.39	16
1986	360-420	143-167	0.39	21
1987	360-480	143-167	0.37	24
1988	360-540	143-167	0.33	25
1989	360-540	143-167	0.33	28

Linear regression between cage area (x) and average daily increment (y): $y = 0.9772 + -0.027\,x; (r = -0.713)$

Table 27. R & D expenditure in agriculture, natural resources and fisheries as percentage of GVA in agriculture, fishery and forestry, Philippines, 1986 to 1995 (in million pesos) (Source: GVA from NSCB, 1998; R &D Expenditures from PCAMRD, 1996)

Year	GVA	R & D Expenditure	% of GVA
1986	145,807	1,058	0.72
1987	163,927	337	0.21
1988	183,515	1,133	0.62
1989	210,009	1,071	0.51
1990	235.956	1,147	0.48
1991	261,868	1,248	0.48
1992	294,922	1,387	0.47
1993	318,546	2,524	0.79
1994	372,507	2,502	0.67
1995	412,197	2,713	0.66
Average	259,925	1,512	0.58

Table 28. Source of credit of municipal fishermen in five municipalities in the provinces of Iloilo, Antique and Guimaras, Panay Island, Philippines, 1990 (From Samonte and Ortega, 1992).

Source		Number	% of Borrowers
FORMAL			
	Government Bank	1	
	Rural Bank	2	
	Credit Union	3	
	Commercial Bank	1	
Sub-total		7	2.4
INFORMAL			
	Relatives	93	32.0
	Friends	102	35.2
	Traders	31	10.7
	Private Lenders	7	2.4
	Store	37	12.8
	Employer	10	3.4
	Barangay Funds	3	1.1
Sub-total		283	97.6
Total Number Of Borrowers		290	
Total Number of Respondents		350	

Table 29. Factors considered by fishermen in the selection of credit source, Panay Island, Philippines, 1990. (From Samonte and Ortega, 1992).

Factors	Number	Percent
Accessibility	144	51
Fast credit extension	87	31
Liberal terms	72	25
Only source known	50	18
Buyer of produce	18	6
For household items	6	2
Others	4	1
Number of Informal Borrowers	283	
Total Number of Respondents	350	

NOTE: Total percentage is more than 100% since fishermen considered more than one factor in the selection of credit source.

Table 30. Production loans granted under the fisheries sector, Philippines, 1992 to 1997. (From Kraft, 1998).

Year	Total Agricultural Loans		Loans to Fisheries		
	Amount (million PHP)	Growth (%)	Amount (million PHP)	Growth (%)	% Share to Total Agriculture Loans
1992	56,057.9	-	7,063.3	-	12.6
1993	54,488.0	(2.8)	8,173.2	15.7	15.0
1994	56,382.8	3.5	8,852.1	8.3	15.7
1995	62,765.7	11.3	9,352.1	5.6	14.9
1996	69,666.6	11.0	9,405.0	0.6	13.5
1997	75,043.2	7.7	10,581.1	12.5	14.1
Average	62,400.7	6.1	8,904.5	8.5	14.3

Table 31. Total area covered and production levels of farms participating in the National Rice-Fish Culture Program, 1979 to 1986 (from Sevilleja, 1992)

Year	Total Area (ha)	No. of Farms	Ave. Area per farm (ha)	Production (kg/ha)	
				Rice	Fish
1979[a]	193	428	0.45	4,965	115
1980	249	446	0.56	5,150	208
1981	497	1,141	0.44	5,015	155
1982	1,3997	2,284	0.61	5,010	174
1983	759	1,237	0.61	4,450	164
1984	424	932	0.45	3,900	152
1985	607	1,177	0.52	4,300	119
1986	185	550	0.34	3,850	140

a. May to October only

Figure 1. Map of the Republic of the Philippines showing the administrative regions and provinces.

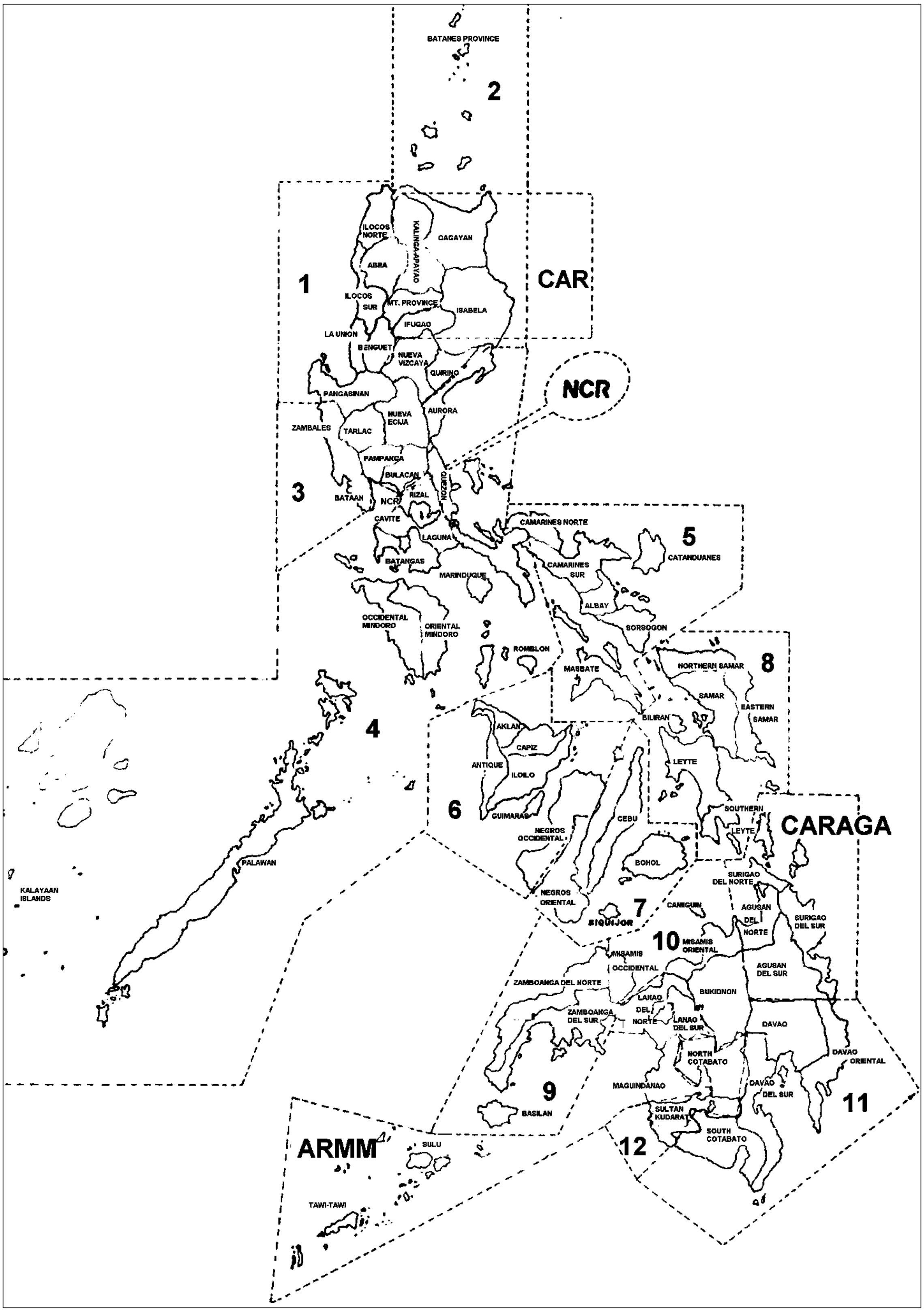


Figure 2. Philippine fisheries production by sector, 1988 to 1997.

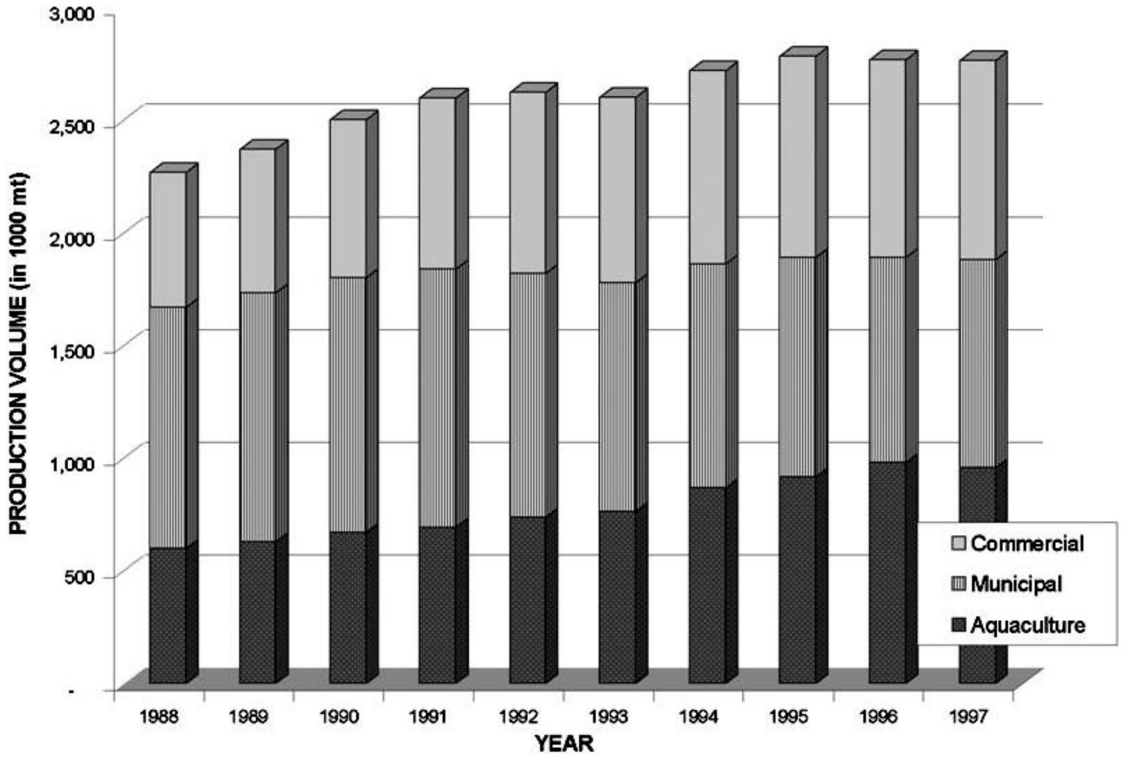


Figure 3. Contribution of different sectors of fisheries to total fish production, 1988 and 1997.

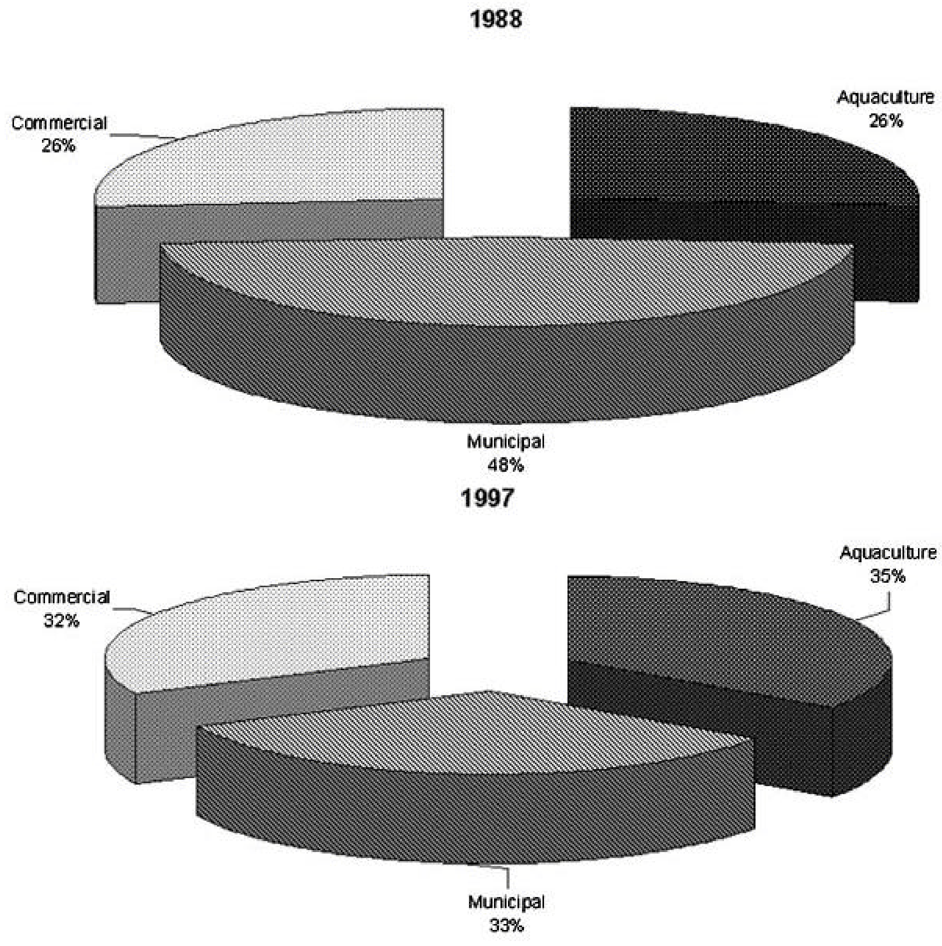


Figure 4. Annual growth rate of Philippine aquaculture industry, 1989 to 1997.

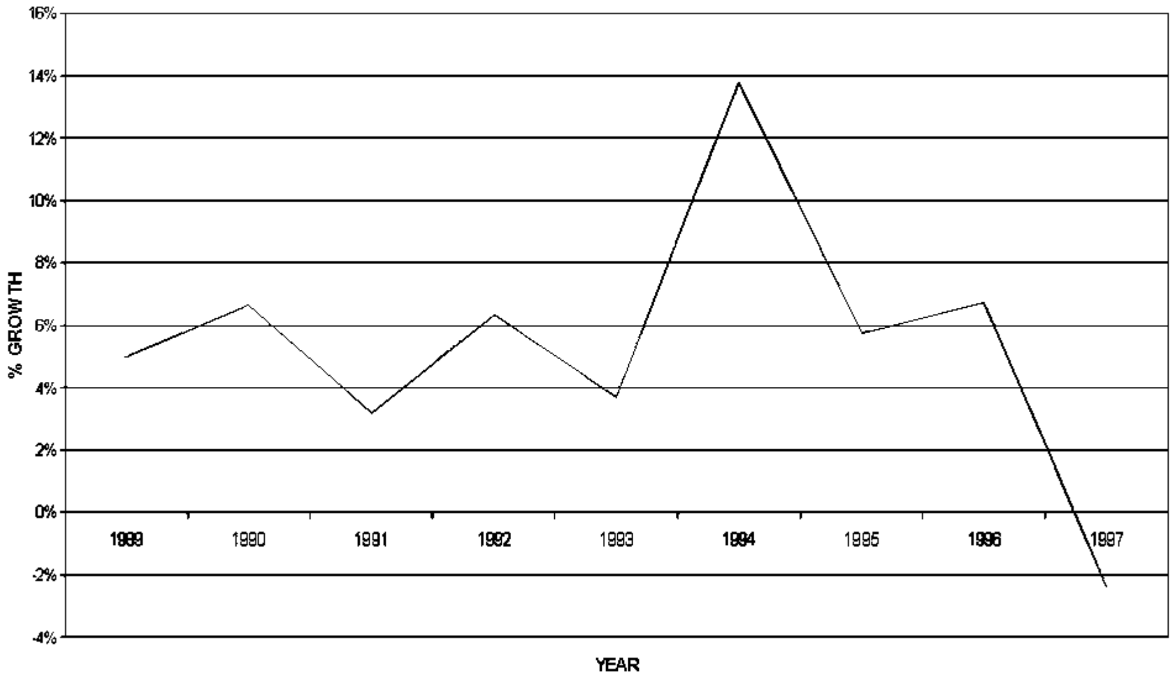
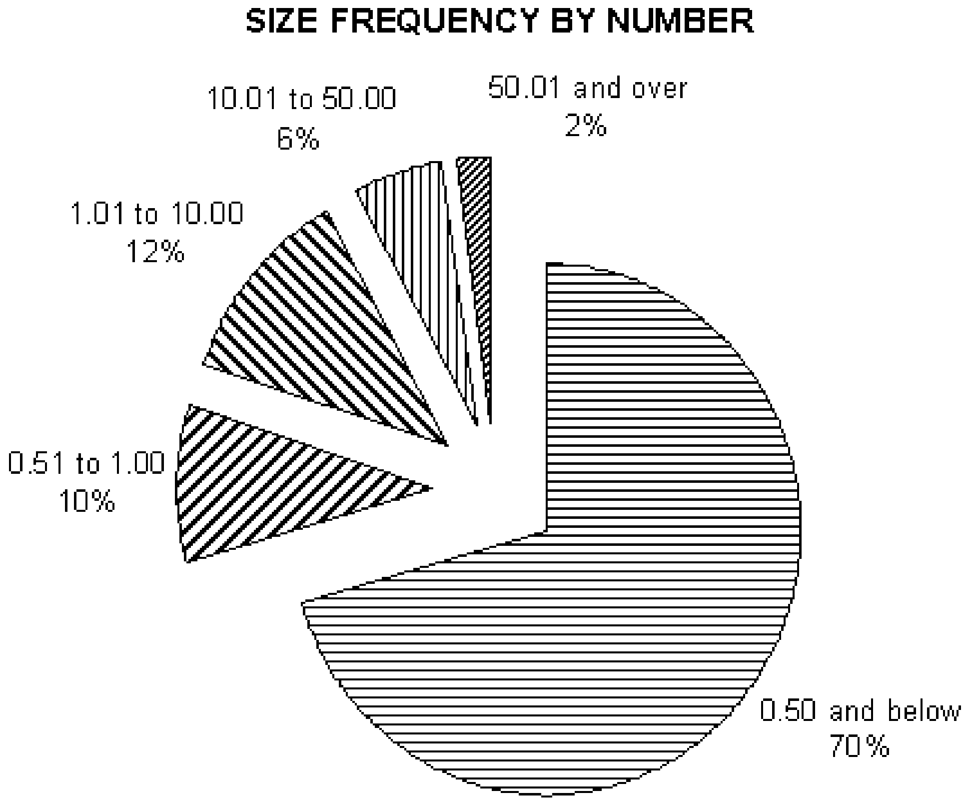


Figure 5. Size distribution of freshwater fishponds in Central Luzon, Philippines by number and by area, 1997 (from Reyes et al, 1992)



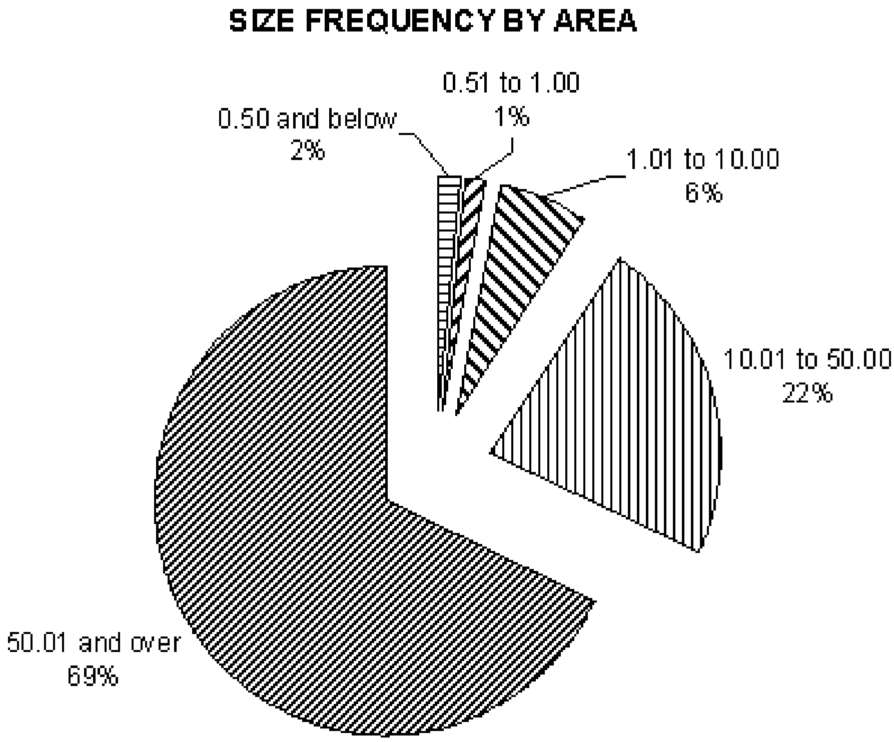


Figure 6. Fish Production from Freshwater Cage Culture, Philippines, 1985 - 1997 (Bureau of Agricultural Statistics, various years)

Figure 7. Size frequency of 640 fish cage farms in Laguna de Bay, Philippines. Each farm may consist of more than one cage unit. (Based on LLDA registration records for all municipalities, except Binangonan, Rizal, as of 1998.).

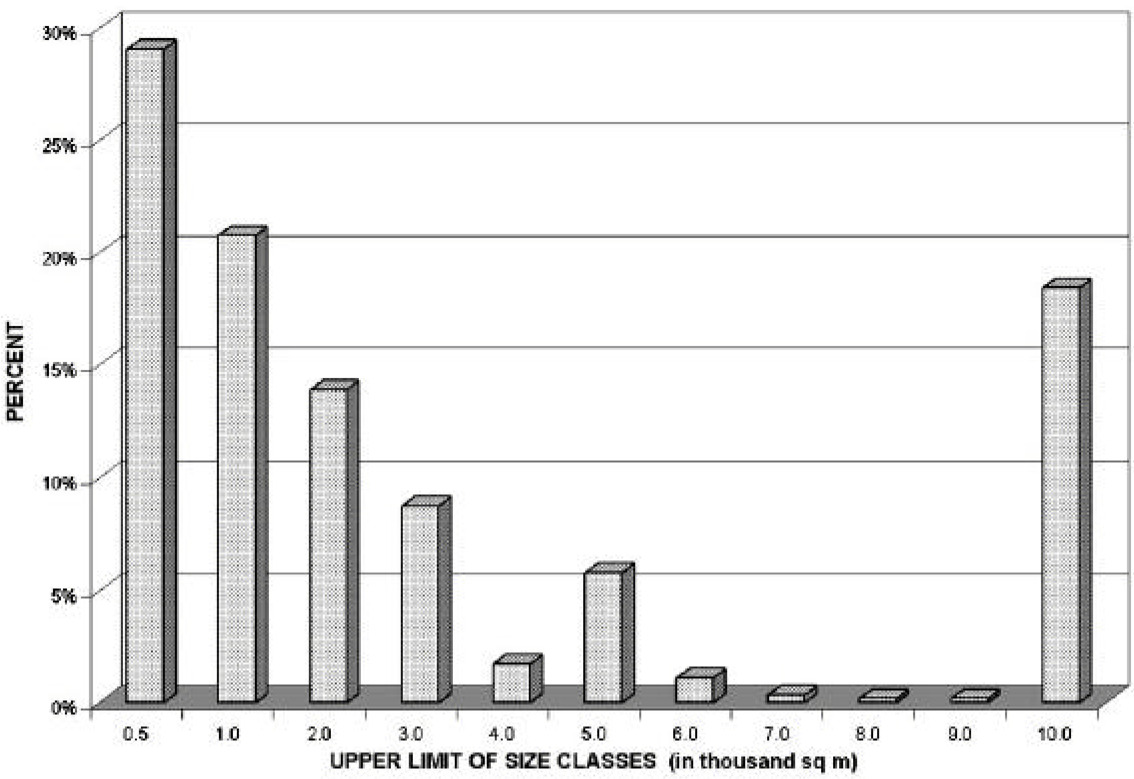


Figure 8. Seaweed production, Philippines, 1981 to 1997
(Bureau of Agricultural Statistics, various years)

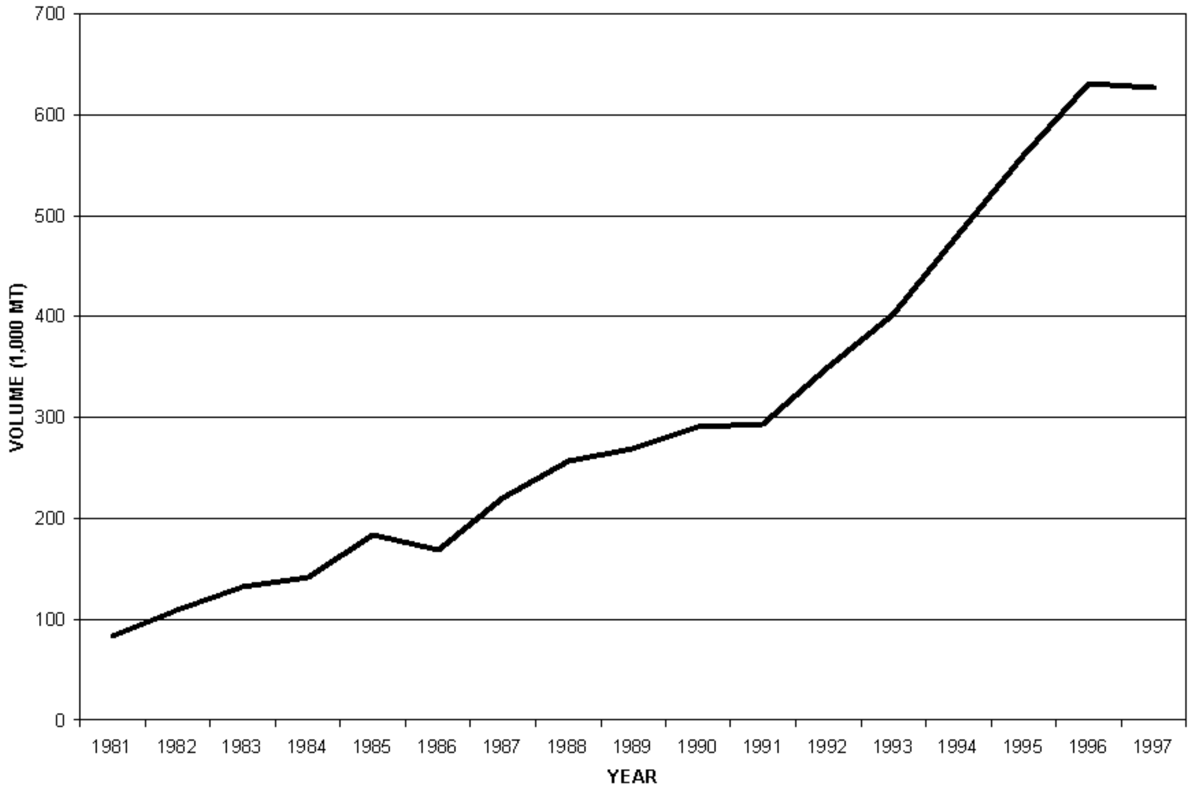


Figure 9. Production of oysters and mussels, Philippines, 1985 to 1997
(Bureau of Agricultural Statistics, various years).