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EDITORIAL

Aquaculture and World Aquatic Resources

Catches from fisheries in inland and marine waters have declined over the last few years after several decades of sustained growth. This decline is expressed not only in terms of the absolute volume of catch but in the size and quality of the fish. There is a rising demand for fishery products which, together with a failure in management has created over-capacity in the fishery and over-fishing of many stocks. At the same time there has been a sustained degradation of the environment firstly in inland and later in coastal waters which has attacked the capacity of ecosystems to sustain aquatic life. Production from aquaculture continues to increase although there are great geographical differences in growth rate and potential. The majority of aquaculture production comes from Asia and in particular from China and although these regions sustain high growth rates this can not be extrapolated indefinitely into the future. Aquaculture development in the industrialized countries of North America and Europe is generally static but high potentials for future expansion of rural aquaculture remain in South America and Africa which have not yet been realized because of social and economic constraints. There is also a trend throughout much of the world to increase production from aquatic systems through intensification of use of existing natural and artificial waters. Intensification begins simply with methods for enhancing fisheries in natural waters but in some areas has led to the development of such control of the system as to be consistent with aquaculture. Some doubts have been expressed at the continuation of the current high rates of growth from existing types of aquaculture due to the appearance of a number of constraints including availability of feeds, pollution and other environmental problems, limited food and declining seed supplies, limitations in space, occurrences of diseases and the performance of markets. What is popularly considered rural aquaculture is in most places constrained by social and economic factors and has not lived up to earlier expectations. Equally, trends to intensification may reach naturally imposed limits although more often problems are also socio-economic in nature. There are, for instance, problems of ownership and distribution of benefits which need to be solved in both inland and marine waters. Conflicts are also common in temperate countries where the growing demand for environmental quality is leading to the retirement of waters as productive systems. In summary, present information seems to indicate the following trends in the short to medium term: stabilization or continued decline of capture fisheries; continued but slower growth of intensive aquaculture; rapid growth of intensified management.

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COASTAL AQUACULTURE IN THAILAND

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Coastal Aquaculture Production

More than half of the total volume of aquaculture production in the Asia-Pacific region comes from coastal areas. In 1991, with her 230.4 thousand tons of coastal aquaculture production, Thailand was the sixth among the major producers in the region after China, Japan, the Republic of Korea, the Philippines and Indonesia (Figure 1). Considering the differences in size and natural resources among the countries, a better way of comparing countries in terms of coastal aquaculture production is to use an indicator such as the average volume of production per kilometer of the coastline.

Coastal aquaculture in Asia and the Pacific is, in fact, dominated by seaweeds and molluscs. In 1991, seaweeds contributed 51.1% and molluscs 30.6% to the total regional volume; the share of finfishes was a low 10.2% and that of crustaceans only 8.1% (Figure 2). In Thailand, the commodity ratios are quite unique: coastal aquaculture production is dominated by crustaceans that added up to 70.3% of the total volume in 1991. The second most important commodity group was molluscs with a share of 28.8%, while marine fish provided only 0.9%. Cultured seaweed production was not reported at all (Figure 3). The rapid growth of Thai coastal aquaculture was made possible by the development of a number of new culture technologies in early eighties, and the spectacular growth in Thai coastal aquaculture started only in 1986. The most important of these were the introduction of cage culture of marine fish, mass production of shrimp seed in hatcheries and intensive methods of shrimp culture.

Coastal finfish culture

Coastal finfish culture started in Thailand as a secondary utilization of traditional salt pans during the rainy season. Juveniles of estuarine fish species, primarily milkfish (*Chanos chanos*), Asian seabass (*Lates calcarifer*) and mullets (*Mugil* spp.) were trapped in these shallow ponds together with shrimp and crab seed and were grown there with or without supplementary feeding until the end of the rainy season. Milkfish and mullets are rather well suited to such a system; however, market demand for these species is rather low in Thailand. Seabass, on the other hand, is a popular and highly priced species, but its seed are less abundant in the nature.

As profitability of salt production declined, suitable salt ponds were used year-round to produce fish. Expansion of seabass culture was limited by the meagre natural seed supply. However, by 1973, suitable methods of artificial breeding were developed and taken up subsequently by the private sector. By the early 1980's, beside covering the domestic demand, seabass hatcheries established in Thailand became major exporters of seed to Hong Kong, Malaysia, Singapore and Taiwan. Moreover, Thai experts were instrumental in introducing seed production techniques to other countries of Southeast Asia.

In sixties and seventies, the salt ponds were converted to fish (milkfish and seabass) farms and then in eighties into shrimp farms. Fish culture during this period shifted from pond culture to cage culture of highly priced species of seabass (*Lates* species) and then to grouper (*Epinephelus* species). In 1991, 2.1 thousand tons of marine fish was produced, of which seabass represented about 80% and grouper about 17%. The success of seabass cage culture can be attributed to the success of the Thai experts in developing artificial breeding techniques for seabass. Most of the coastal finfish culture is concentrated along the coast of Chonburi, Chacheonsao and Samut Prakan Provinces.

Because of economic, marketing and biotechnological constraints and because of the fact that only a very few species are being cultured, Thailand's rank among the major producers is rather low (Figure 4). In 1991, with her less than 1 t/km coastline national average, the country was ninth in the region despite the achievement of significant research breakthroughs in seabass and grouper culture. Production per kilometer of coastline of the Philippines, Japan and Taiwan surpassed that of Thailand by about 14 times, 25 times, and 35 times respectively.

Coastal crustacean culture

Shrimp culture started in Thailand in extensive trapping-growing ponds, which yielded a mix of fish and crustacean species. There are no records from the early years; however, in 1969 there were already 1,052 shrimp farms covering an area of 7,825 hectares and yielding some 3,440 tons of crustaceans. Many of these farms were converted salt ponds, their yields fluctuated widely between 250 and 900 kg/ha, depending on the success in trapping wild seed. Main shrimp species produced at that time were banana shrimp (*Penaeus merguiensis*), school shrimps (*Metapenaeus monoceros, M. ensis*), Indian white shrimp (*Penaeus indicus*) and some black tiger shrimp (*Penaeus monodon*). During the 1970's production techniques and volume of annual production did not change significantly; in 1980, cultured crustacean production was still not more than 8 thousand tons.

In the early 1980's, however, Thailand started to increase the intensity of shrimp culture through the use of simple and cheap "push-pumps" in the traditional technology. Average yields, therefore, started to surpass considerably those of other Southeast Asian countries using the same extensive trapping/growing techniques. Improved water supply made a considerable increase in stocking densities feasible, consequently the demand for shrimp seed expanded rapidly. Thailand has never relied upon collected wild seed. The first large-scale hatcheries with imported technology started to produce postlarvae in the early 1980's, but the real breakthrough was brought about by the proliferation of small- and medium-scale hatcheries that used a simplified, indigenous technology.

Although scarcity of seed hindered the expansion of shrimp culture in the first half of the 1980's, seed production improved rapidly in the second half of the decade. During the same period, with the increase in production of shrimp feed and the expansion of processing capacity, shrimp production increased rapidly in Thailand; and by 1991, it became the world's leading producer of cultured marine shrimp with a production of 162 thousand tons per year.

By 1991, black tiger shrimp became dominant, representing 95.7% of the total production; banana shrimp represented only 3.6% and other penaeids (including school shrimps) a marginal 0.7% (Figure 5). National average yield surged from 0.39 t/ha in 1985 to 2.15 t/ha in 1991, demonstrating a rapid shift from extensive polyculture techniques to semi-intensive monoculture and increasingly to intensive culture system. In one respect there was no substantial breakthrough: seed production continues to depend on captured wild breeders, this is becoming an important constraint of the industry.

Although among the marine crustaceans shrimps are by far the most important species both in terms of volume and value, there is an increasing interest in developing mass production techniques for other species with commercial potentials. Mud crab (*Scylla serrata*) is one of the most promising candidates. Due to the decline in natural populations and an increasing ratio of small, undersized crabs in the catch, there are considerable domestic and export market potentials for this species. Traditionally, mud crab culture is carried out primarily in Surat Thani, Nakhon Si Thammarat, Chantaburi, Rayong, Krabi, Satun and Pattani provinces. Samut Songkhram province had also many crab farms before the shrimp boom. Traditional production techniques are based on captured stock; captive breeding of the mud crab is not yet commercialized.

The volume of cultured mud crab peaked with 223 tons of production in 1986 when there were more than 100 small crab farms in Thailand. These, however, almost disappeared when suitable coastal lands were converted to more profitable shrimp farms. In 1991, only 4 t of cultured mud crabs were reported. However, mud crab culture is receiving high priority as this species can be cultured in abandoned shrimp ponds.

Cage culture techniques for local spiny lobster species (*Panulirus ornatus, P. vesicolor* and *P. longipes*) were also tested and found to be promising. Like the mud crab, current efforts are aimed at raising small captured individuals to marketable size.

Marine mollusc culture

In Thailand, mollusc culture started nearly one hundred years ago, cockle and green mussel culture techniques being the oldest. In 1969, there were 74 mussel farms on 222 hectares, 152 oyster farms on 55 hectares and 182 cockle farms on 625 hectares producing 40, 000, 6 000 and 15,000 tons, respectively. The total volume of cultured molluscs was estimated at 61,000 tons in 1969. The annual production went down to a mere 18,800 tons in 1986 and then peaked at 73,000 tons in 1990. As significant export outlets were not developed for the cultured molluscs, saturated domestic markets resulted in depressed prices.

Mollusc culture in Thailand has always been dominated by green mussel production. However, this dominance weakened somewhat in the 1980's. In 1981, green mussel represented 68.2% of the total production. However, this ratio was reduced to 53.5% by 1991 (Figure 6). The share of oysters was 14.1% in 1981 and this decreased to 5.0% during the same period. The only cultured mollusc that has shown significant increases both in volume and in ratio were cockles. While in 1981 cockles contributed only 15.2% to the total, their share reached 39.9% by 1991. On the whole, potential for mollusc culture is very good. As mollusc culture is environment-friendly and as it offers a viable alternative use of abandoned shrimp ponds, concerted efforts to improve processing and marketing of the products should be made. Efforts are also underway for the development of commercial culture of scallop (*Amusium pleuronectes*) and abalone (*Haliotis ovina* and *Haliotis diversicolor*).

Seaweed culture

Seaweed production in the Asia-Pacific region is an important coastal aquaculture activity, providing substantial employment and income for coastal communities. Major producers are the Republic of Korea, China, the D.P.R. Korea, Japan and the Philippines. Despite the existence of substantial seaweed resources and of a modest export business of dried seaweeds (mainly *Gracilaria*), culturing seaweeds in commercial quantities has not yet developed. Local fishermen collect indigenous *Gracilaria* or *Polycavernosa* species from natural beds or seabass/grouper cages and sell the dried seaweeds to middlemen in Trat, Chantaburi, Songkhla, Pattani and Trang provinces. Most of the collected seaweed is exported; the export volume varies from 60 to 200 tons annually. A simple method for extracting agar-agar from suitable seaweed species by the rural families for use in traditional sweets has been developed by the Biopolymer Research Unit of Srinakarinwirot University. This method has raised some interest in seaweed culture and utilization, especially in the southern provinces. Similarly, experiments to utilize intensive shrimp pond effluents for growing seaweeds has shown initial success. However, lack of domestic processing facilities and depressed export prices are the main constraints to the expansion of seaweed culture in Thailand.

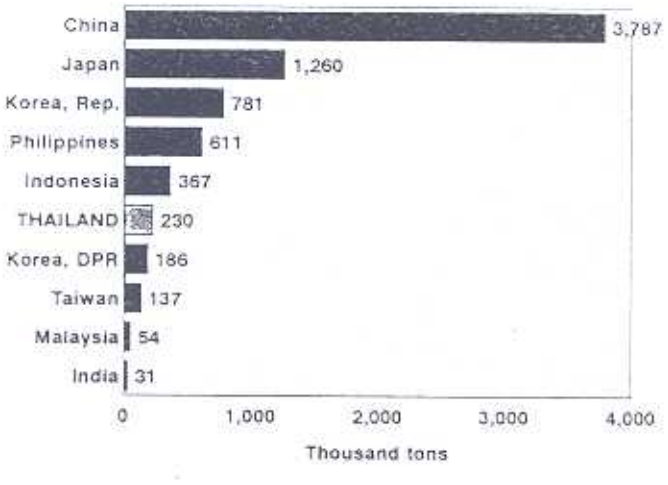

Figure 1: Major producers of coastal aquaculture commodities in Asia in 1991 (data from FAO 1993)

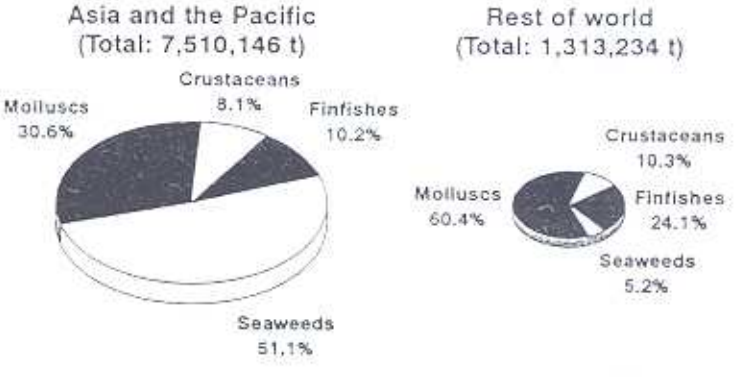

Figure 2: Coastal aquaculture production by major commodity groups in 1991 (data from FAO 1993)

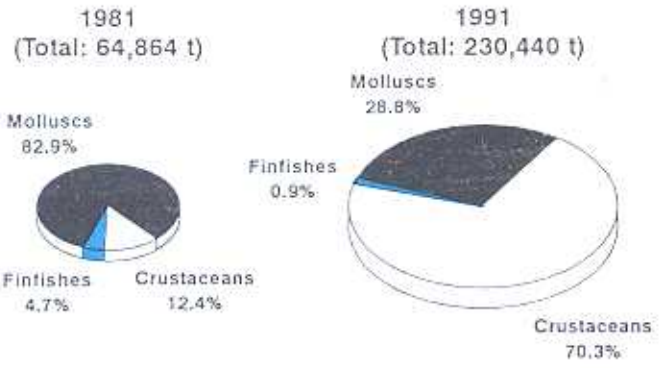

Figure 3: Major commodity groups in coastal aquaculture production in Thailand in 1981 and 1991 (data from DOF Fisheries Statistics)

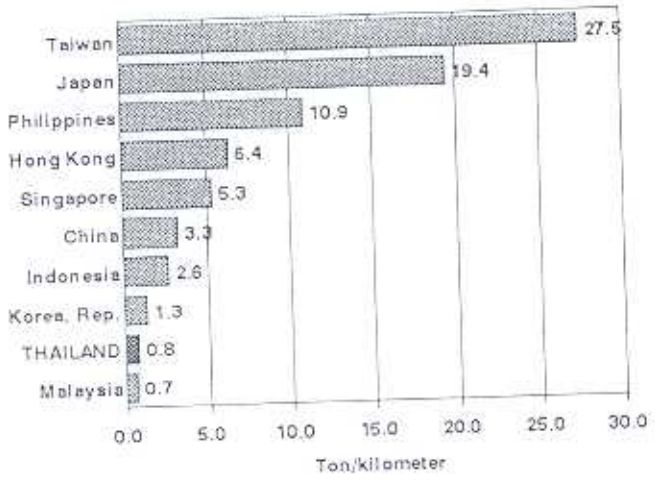

Figure 4: Major cultured marine fish producers in Asia in 1991 per km of coastline (data from FAO 1993)

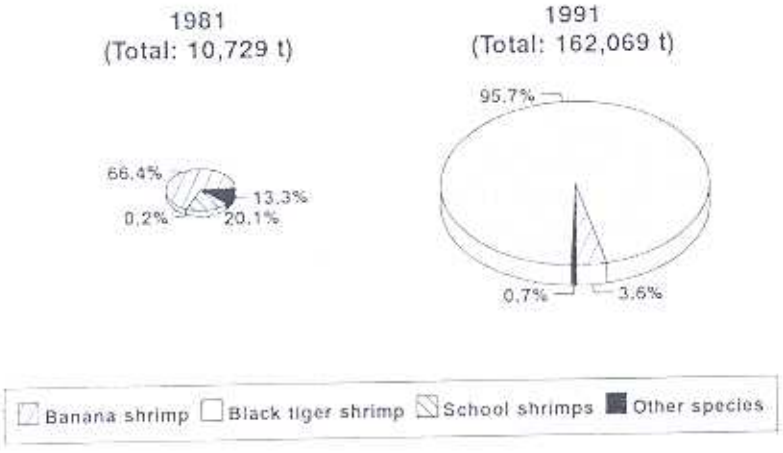

Figure 5: Species composition of cultured shrimp in Thailand in 1981 and 1991 (data from DOF Fisheries Statistics)

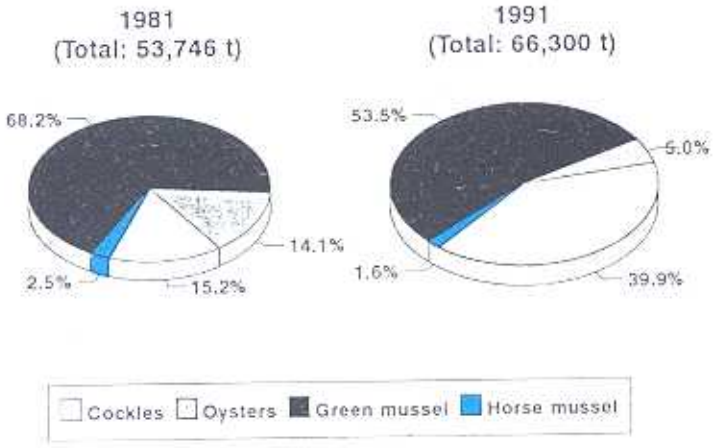

Figure 6: Species composition of cultured molluscs in Thailand in 1981 and in 1991 (data from DOF Fisheries Statistics)

DEVELOPMENT OF SEAWEED CULTURE IN THE PHILIPPINES

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Background

The seaweed production development project (PHI/89/004) is one of the actions recommended by the National Conference on Fisheries Policy and Planning sponsored by the UNDP/FAO in March 1987. The project proposal was approved in April 1991 and the project started operating in August 1991. The project is financed by the United Nations Development Programme (UNDP) and is executed by the Food and Agriculture Organization of the United Nations (FAO). The Bureau of Fisheries and Aquatic Resources of the Department of Agriculture (BFAR/DA) is the national counterpart Agency.

The project strategy has been designed to cover two development levels: (a) the institutional level where knowledge/ skills/ technologies would be enhanced for planning/ pilot testing purposes; and (b) the direct beneficiaries level where incomes and employment opportunities would be improved as a result of the community- based seaweed resource management strategy adopted by the project.

The development objective of the project is to contribute to the improvement of the socio-economic conditions of fishing communities dependent on coastal fisheries for livelihood, by developing alternative employment and income opportunities through an extended and diversified seaweed farming and processing industry.

The immediate objectives of the project are to develop farming and processing technologies of *Gracilaria* species and to train the members of the families of the coastal fishermen and government counterpart officials. The seaweed *Gracilaria* is one of the major sources of raw material for the manufacture of agar. Its crude form is used by the food processing industry, while its more refined form is utilized in pharmaceutical and biomedical applications.

The project area covers coastal towns along Eastern Sorsogon and Sorsogon Bay . Families of the fishermen from the project area are the direct beneficiaries of the project and they are organized as the core of community-based seaweed farming and processing organizations.

Gracilaria in the Philippines

Taxonomic studies have identified eleven species of *Gracilaria* from Sorsogon, five of which are found to have good potential for farming in Sorsogon and other parts of the Philippines. They are namely: *G. firma* (figure 1), *G. fastigiata, G. changii, G. heteroclada* and *G. tenuistipitata* var lui.

Studies have revealed that Sorsogon area is rich in *Gracilaria* resources both in quantity and quality. Naturally rich *Gracilaria* beds have been found both in the east coast and Sorsogon Bay, notably in Magallanes where approximately six hectares have been reserved for conservation purposes. The local gatherers and authorities have been made aware of the imortance of management and conservation of natural beds of *Gracilaria* found in the area.

Farming

In general, following three types of areas with their specific environmental conditions can be found for *Gracilaria* farming purposes.

Open Sea - open sea coralline flats protected by reef breakers at the fringes, off the coast. High salinity (33-35ppt), clear water with firm coralline substrate.

Bays - protected bays, mangrove channels along coast line, channels within coastal mangrove islands and river estuaries with little freshwater influence. High salinity (25-35ppt), semi-clear water with sandy-mud substrate.

Brackishwater ponds - unused fish ponds, supply/drainage canals of fish ponds and/or mangrove ponds. Lower salinity(10-25ppt), turbid water with muddy substrate.

Three methods of farming have been developed, namely - fixed bottom line, floating raft line and pond culture (monoculture and polyculture) using the five species in their preferred area and environment (figures 2, 3 &4). Five demonstration farms are in operation utilizing the areas identified and the methods developed: three at the East Coast, namely- Prieto Diez, Gubat and Bulusan and two in Sorsogon Bay, namely- Juban and Magallanes.

An average daily growth percentage recorded within 45 to 50 days of growing period, at optimum environment for the five *Gracilaria* species are as follows: *G. changii* = 9.0%; *G. firma* = 8.7%; *G. fastigiata* = 9.0; and *G. heteroclada*/*G. tenuistipitata* = 6.2%. Growth can be compared with the average daily growth of 5 % as estimated for *Eucheuma* in commercial farming. Generally, from the line farming, a production of 4.0 tons (dried) can be expected from one hectare after 45 to 50 days cycle in an optimum environment. A maximum production of 12.0 tons (dried) can be obtained from one hectare pond monoculture.

Processing and agar quality

A *Gracilaria* processing and agar quality analysis laboratory at BFAR, Quezon City and a field support laboratory at Cabid-an, Sorsogon have been established. The laboratories have attained a high standard of performance. The agar quality (average gel strength) of the five *Gracilaria* species are: *G. changii* = 963 g/cm^2; *G. firma* = 765 g/cm^2; *G. fastigiata* = 890 g/cm^2; *G. heteroclada* = 968 g/cm^2; and *G. tenuistipitata* = 433 g/cm^2.

Considering the facts that for bacto-agar (bio-medical and plant tissue culture media) and agarose (pharmaceutical use) require a gel srength of 600-800 g/cm2 and 800-1000 g/cm2 respectively, the quality of the *Gracilaria* species from Sorsogon in terms of gel strength can be considered as very good. A village level *Gracilaria* processing plant has been established and is producing food agar in Sorsogon (figures 5 & 6). With additional funds from UNDP, DA-BFAR and Local Government of Sorsogon, a Prototype Processing Plant to produce five tons of food agar and one ton of bacto-agar annually is under construction in Sorsogon. The plant is due to be completed by the end of this year (1994).

Socio-economics and marketing

The estimated income level of coastal households in the area ranges from 2000 to 3560 Pesos per month (UN exchange rate for May 1994 - Peso 27.30 = US$ 1.0). About 39% of the population are engaged in fishing, which is their main source of income. Nine registered cooperatives and a number of community based groups are actively involved in seaweed farming and processing. An economically viable farm size for a farmer/fisherman family (a family of four to five) should be one hectare. The cost of production of a farm will vary depending on the locality and availability of farm inputs. The major production costs will be the seedlings, stakes and lines. The operation cost will be much reduced if the seedlings are collected by the farmer's family to start the operation. The unit cost of production will also be less from year two onwards.

A family size processing plant that produce one kg of food agar per day (288.0 kg per year) is an ideal size. However, with extra hands, the production can be increased to a maximum of 3.0 kg per day using the same facilities with additional minor equipments. A simple example of seaweed farming and processing is summarized in Table 1.

Table 1: Simple economics of *gracilaria* farm and processing plant (year 1)

Description	Farming	Processing
Type/size of operation	Family type 1 ha farm	Family type plant
Method	Fixed bottom line 4 crops	Dewatering by press
Production per year	16,000 kg (dried)	288 kg agar powder
Sales Income (Pesos) (10.00 pesos/kg)	160,000	288,000 (1000 pesos/kg)
Cost of production	51,000	117,000
Unit cost	3.2 pesos/kg	406.2 pesos/kg
Net income (Pesos)	109,000	171,000

A Federation of Cooperatives has been formed to establish market linkages between farmers, gatherers, processors and domestic market outlets. In 1993, the Philippines exported an estimated US$ 45 million worth of PNG (Philippines Natural Grade) or semi-refined carageenan, a product of farmed seaweed *Eucheuma*, to the United States, Japan, South America, Canada and other markets. At present, the Philippines is importing about 21.0 tons of agar-agar and 185 tons of mucilage/thickeners which are products of seaweed

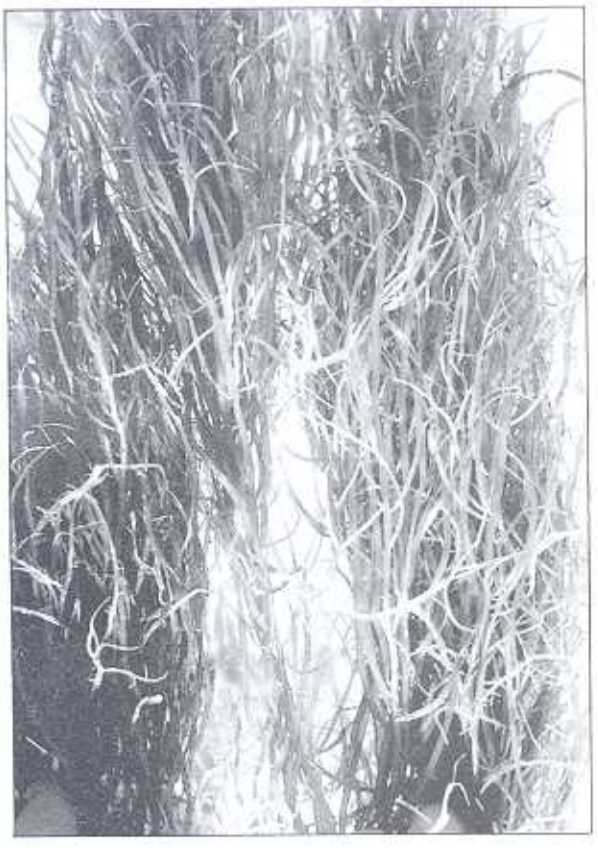

Figure 1. Gracilaria firma from east coast of Sorsogon

Figure 2. Gracilaria on line farming ready for harvest at Bagacay, east coast of Sorsogon

Figure 3. Gracilaria line farming in river at Magallanes, Sorsogon

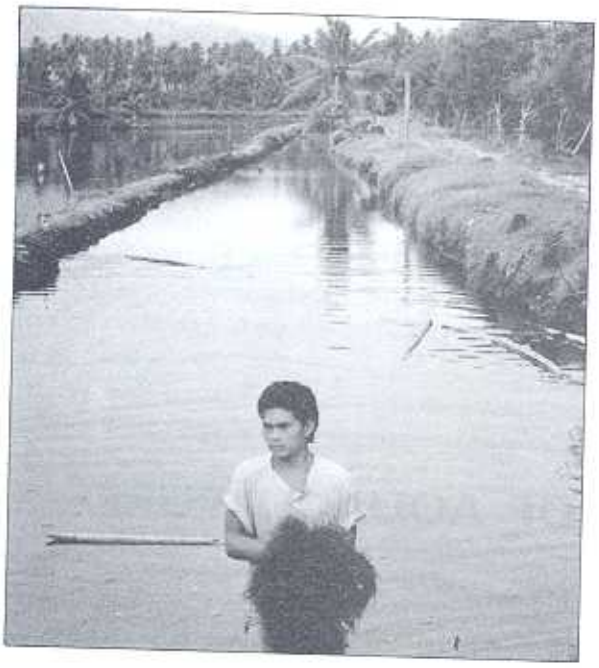

Figure 4. Harvesting Gracilaria from canal of brackiswater fish culture pond

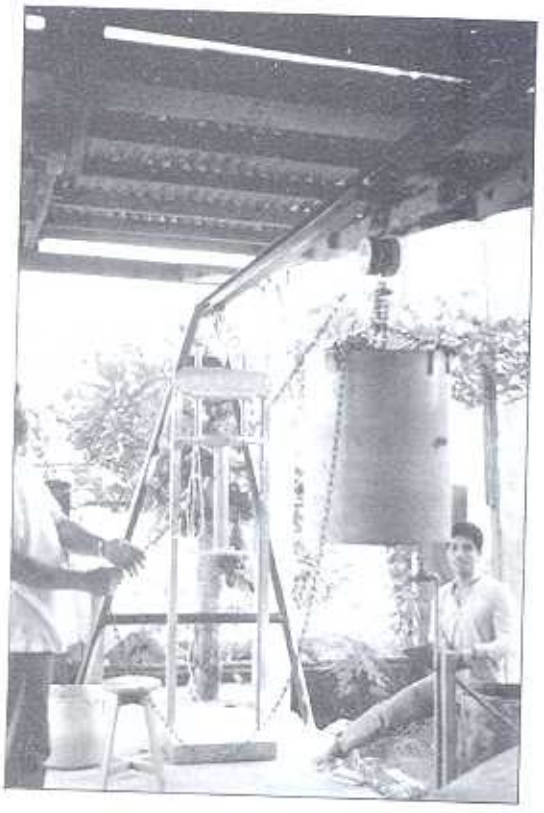

Figure 5. Part of a village level agar processing facility in Sorsogon

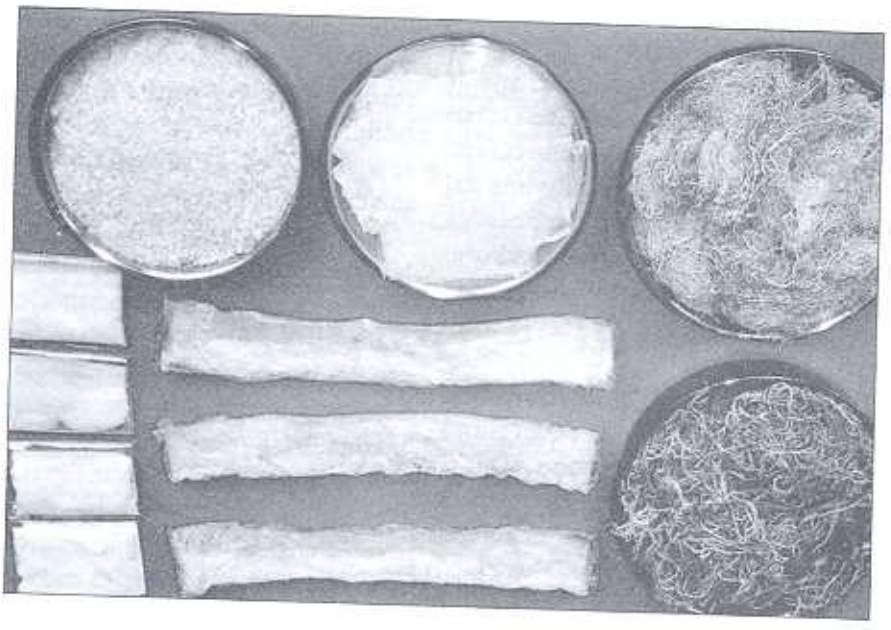

Figure 6. Various products (dried Gracilaria , agar strips, agar flakes and agar powder) from village level processing plant

Gracilaria, per year. Apart from pharmaceutical and biomedical industries which utilize bacto-agar and agarose, there are ten large food processing companies in the Philippines which use food agar as an ingredient in their products. This clearly indicates that there is a ready domestic market for food agar and bacto-agar.

The project has conducted a number of in-country training courses on various subject matters such as resource management, farming technology, management of cooperatives, marketing, processing technology etc., and has trained 40 government officials, 130 field technicians and 539 farmers. In addition, 26 government officials were sent abroad for training through study-tours, participation in workshop, etc. The project has also published a number of interesting manuals/guides on seaweed farming, processing and resource management.

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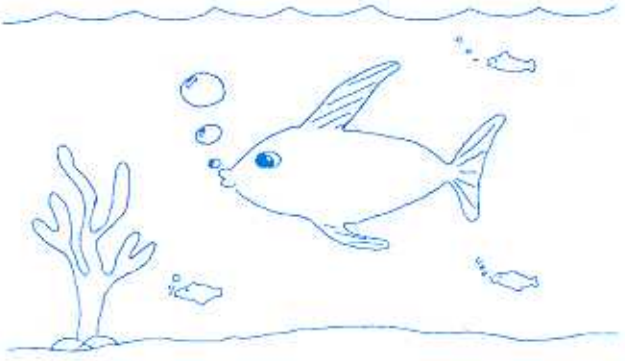

THE LEGAL REGIME OF AQUACULTURE

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Development Law Service

Introduction

This paper is intended to be the first in an occasional series on the legal aspects of aquaculture, and it identifies the preliminary issues to be addressed when considering the legal regime of aquaculture. Subsequent papers will review legal regimes for environmental management of aquaculture and examine the possible substantive content of laws governing aquaculture. These will also be accompanied by some case studies on the existing legal regimes in certain countries.

Aquaculture has been practised for many centuries, but surprisingly the legal regime governing aquaculture has only recently received detailed attention. This is quite remarkable given that much of the aquaculture activity impinges on matters at the heart of most legal systems. This aspect of aquaculture was well illustrated in a diagram (Figure 1) put on the cover of a study prepared by the Development Law Service in 1989 which indicated the various matters that had to be considered when dealing with aquaculture.

In general, aquaculture activities are expected to be directly affected by the land laws (including the use of public domains such as the foreshore or mangrove areas), the water laws, environmental laws, natural resources conservation, fish and game laws, animal health and animal disease laws, as well as others applying more generally, such as public health and sanitary laws, import and export laws, tax laws, etc.

It is also interesting to contrast the attention received by the subject of marine fisheries which has been a central issue in the evolution of the law of the Sea over the last few centuries; and especially since 1945, when attention focused on the serious issue of how the marine living resources were to be protected, as the notion that the resources of the sea were inexhaustible was being discredited by dramatic evidence of overfishing. Another important difference between the area of marine fisheries and aquaculture is that the former has been treated as a discrete area of study as a topic, whereas aquaculture by its very nature involves a consideration of the various competing uses of the resources on which aquaculture fundamentally depends: land and water, seed and feed, as well as the increasing

awareness of its environmental dimension, and the need to ensure that aquaculture activities both respect the environment and are protected from environmental harm.

The problems of studying the legal regime of aquaculture were brought out very strongly in the first attempt to look at the subject undertaken by the Development Law Service in 1989, which was entitled "A Preliminary Review of Selected Legislation Governing Aquaculture", which was written by A. Van Houtte, N. Bonucci, and W. Edeson. This study was funded by the Aquaculture Development and Coordination Programme. It was based on materials obtained from the legal database at FAO headquarters, and supplemented by other materials derived from selected countries. It first of all classified countries along the following lines:

- those with a specific set of rules on aquaculture;
- those with some specific legislation concerning aquaculture;
- those with an enabling law;
- those with an enabling clause on aquaculture.

It then examined the basic legal requirements for setting up an aquaculture farm, the legal framework governing access to land and water use for aquaculture purposes and governing the relationship between aquaculture and the environment.

This review evidenced that the area of aquaculture from a legal point of view is largely untouched, and that apart from some country specific studies (such as the Law of Aquaculture by W. Howarth for the United Kingdom) much work remained to be done. Since then, two major studies have been undertaken by A. Van Houtte on the subject of the legal regime of aquaculture, which are (a) "Comparative Review of the Legal Framework Governing the Environmental Management of Aquaculture in the Asian region", and (b) "Survey on Legislation Relating to Licensing of Fish Farms and Aquatic Pollution Control Relevant for Freshwater Aquaculture in EIFAC Member Countries".

A major threshold question regarding the study of the legal regime of aquaculture is how aquaculture should be defined. It is defined in the Oxford Dictionary as "the cultivation of plants or breeding of animals in water", which seems straightforward enough, though, for legal purposes, it will be seen, such a definition is insufficient.

In 1988, the Aquaculture Steering Committee of the Fisheries Department of FAO defined aquaculture in the following terms:

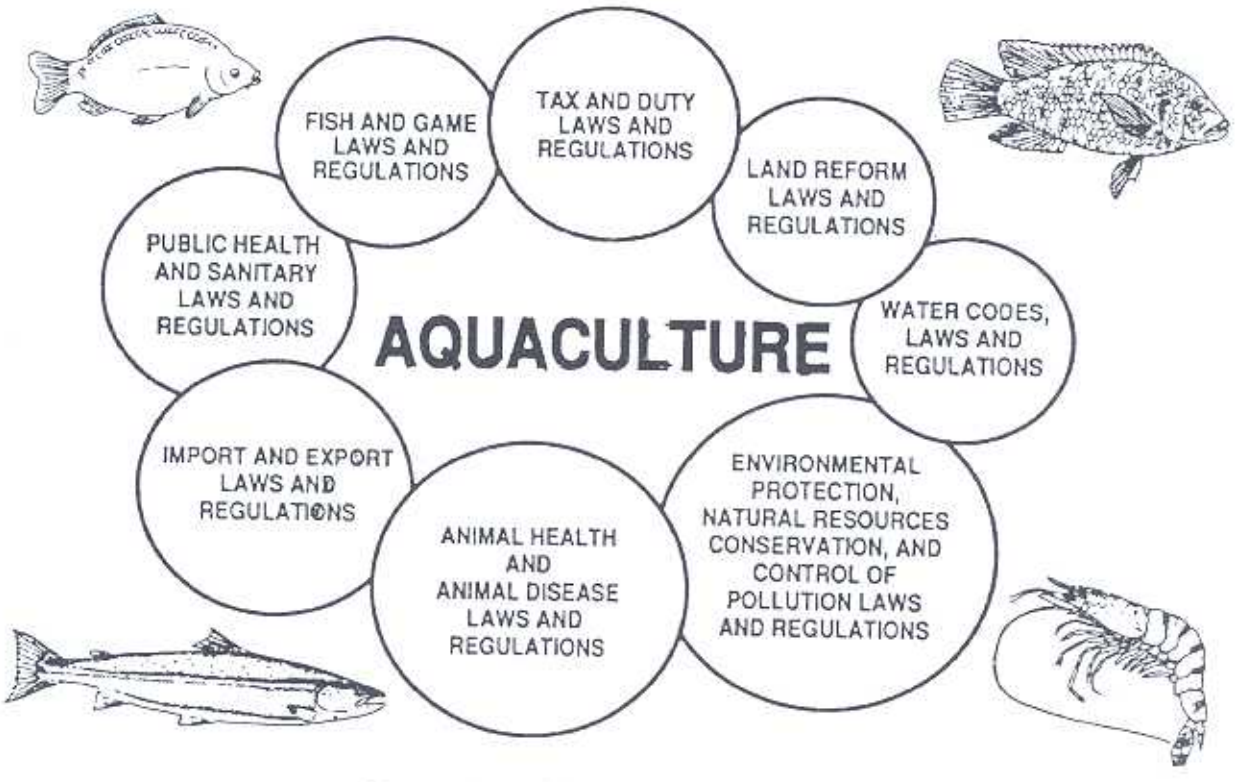

Figure 1. Laws affecting aquaculture activities

"Aquaculture is the farming of aquatic organisms, including fish, molluscs, crustaceans, and aquatic plants. Farming implies some form of intervention in the rearing process to enhance production, such as regular stocking, feeding, protection from predators, etc. Farming also implies individual or corporate ownership of the stock being cultivated. For statistical purposes, aquatic organisms which are harvested by an individual or corporate body which has owned them throughout their rearing period contribute to aquaculture, while aquatic organisms which are exploitable by the public as a common property resource, with or without appropriate licences, are the harvest of fisheries."

Since that time weaknesses in this definition have been noticed. Here, the emphasis on ownership, if only for statistical purposes, has the consequence of excluding from the definition several aquaculture activities which would almost certainly be included in the dictionary definition, or even in legal definitions, for it is the nature of the activity rather than the elusive question of ownership of the stock being cultivated which is the central concern.

Before a definition is prepared, following elements ought to be clearly taken into consideration: the purposes of the industry to be regulated, the resources or species it uses, the system or elements it utilizes for production and the environment in which production is conducted. It is important for instance to determine whether the activity of aquaculture takes place on private or public land, in the sea water, brackishwater or fresh water, etc,. Depending on where it takes place, the activity of aquaculture will be governed by a different combination of laws. To illustrate this, if it takes place entirely on private land, it could be subjected to the land laws and the laws governing the use of water; on the other hand, if it takes place in the public domain, such as the foreshore, there are often special rules governing the use of that land. Because of the possible different rules applying on private land/water versus the public domain, it is suggested that it is better to focus legislation primarily on the activity of aquaculture itself, rather than on where it takes place. In this way, the legislation would avoid making what may amount to being artificial distinctions regarding public versus private property. This also achieves a more consistent regime, and is especially appropriate if the intention of regulating it is to bring the activity of aquaculture for the first time under one broad legislative regime.

However, it has to be pointed out that a legal definition of aquaculture is much more important in common law systems where the legislative practice is to include a definition of key terms; while in civil law systems, words such as aquaculture, mariculture, pisciculture, would be applied without the need to resort to a formal definition of such terms.

Following the said approach, a definition of "aquaculture" that could be used in common law systems is one that covers "the culture or husbandry of aquatic species, whether in fresh, marine or brackishwaters and includes any activity or activities carried out at or in connection with an aquaculture facility". This definition will need to be backed up by a definition of aquatic species, and one possibility is to define it along the following lines: "'aquatic species" means any aquatic flora and fauna, including fish, molluscs, crustaceans, aquatic plants, and their seed and eggs.

The definition of "aquatic species" would probably need in turn to be backed up by a definition of aquaculture facility and aquaculture product because they are likely to become crucial in the enforcement phase of the legislation as they will most probably be the central elements in connection with the violations of the legislation. However, each situation will need to be examined separately.

There is another reason for the need to go beyond a definition of "aquaculture" itself, which is that the very nature of the activity of aquaculture requires that collateral issues are covered in the legislation. For example, because some aquaculture takes place in coastal areas (such as in mangroves or along the foreshore), it will be necessary to ensure that the legislative definitions are sufficiently comprehensive to include such areas. In the definitions set out above, this is achieved by the device of concentrating on the activity itself rather than on the location, though supplemented by a generic term for the location (aquaculture facility) and a generic term for the results of the aquaculture activity (the aquaculture product). Controls over the second part of the definition can be achieved by linking the permission to undertake aquaculture in particular localities, and to the introduction of environmental controls over the activity of aquaculture.

Controls over the Aquaculture Activity

Studies conducted to-date within the FAO Development Law Service showed that countries where a degree of aquaculture development has taken place have built up a legal framework which in one way or another allows for controls on the access to aquaculture activities and provides means of preventing or curing the problem of pollution caused and suffered by aquaculture.

The diversity and complexity of the legal frameworks may depend on the legal status of the waters used (public or privately owned - Philippines - France), on the nature of the waters (marine vs freshwater - France, Spain, Sweden, New Zealand, Norway, Rep. of Korea, Malaysia), on the legal status and nature of the land used (coastal area vs inland, private vs public - Sri Lanka, Madagascar, U.K.), on the need for a Government to regulate aquaculture (in general or a specific aquaculture activity - Malaysia, France, HongKong, Ecuador, Singapore) and on the different questions it is called upon to deal with (use of natural/artificial feed, wild/hatchery produced seed, etc.).

Regardless of whether this activity justifies a specific set of rules or not, the most widely used technique for exercising legal and administrative control over aquaculture seems to be an authorization system whereby a governmental entity allows a person/company to operate a fish farm. This authorization is often provided for under the fisheries legislation (e.g. Norway, U.K., Israel, Cyprus, Sweden, Switzerland, Cambodia, Malaysia, Madagascar, El Salvador) or under aquaculture specific regulations (e.g. Ireland, HongKong, Singapore, Malaysia, Republic of Korea, Nepal, Ecuador). In other cases, it is clearly a part of the permit governing access to water and thus provided for under water management laws (e.g. Denmark, Finland, Hungary, Germany) as far as freshwater aquaculture is concerned or the authorizations required under environment protection related legislation.

In those countries which have established a distinct procedure - under a specific set of rules - for obtaining an authorization to set up an aquaculture farm, the procedure allows the Government authorities (i) to limit the access to aquaculture operations in general or to specific aquaculture systems (control over activity), (ii) to direct aquaculture development only in certain areas (control over location), and (iii) to ensure environment friendly management of the fish farm (pollution control - Ecuador, HongKong, Singapore).

Government authorities may either be a central administration usually represented by the Minister of Fisheries or a person acting on his behalf (e.g. New Zealand, Israel, Ireland) or a decentralized authority at either a regional or municipal level (e.g. France, Germany, Italy, Canada). Where different interests might be involved, no authorization will be granted without prior approval by several other agencies (e.g. Sri lanka, Indonesia, Hungary) or in close consultation with other competent government agencies (e.g. Denmark, Scotland, Hawaii, Hong Kong). The review undertaken in Asia and Europe evidenced the authorization may be named in different ways: authorization, licence, permit, lease and concession. All of them are documents which grant a person the right to do something and whereas these terms are often used in distinction to each other, in the area of aquaculture they often amount to the same thing. However, the term found more commonly is a licence to culture which gives, in addition to the authorization to carry out aquaculture, the licensee the right to occupy premises or an area (water/land) for the purposes of aquaculture (HongKong, France, Ecuador, Madagascar) but does not operate to confer on, or vest in, a licensee any title or interest, or estate in such property.

The decision to authorize is usually based on information supplied by the applicant. This seems commonly to include at least three types of documents and information: (i) economic/administrative (names, label, duration requested, production target, financial sources, purpose of intended activity), (ii) geographical (design of premises and facilities, location, map) and (iii) technical (resources/species it uses, production system, water cycle, water quantity and quality, water treatment). The amount of information required varies from one country to another but it appears that the developing countries have more limited requirements as opposed to certain developed countries. Further, the profile of the applicants may be subject to qualifications with the result that a range of prospective applicants is likely to be eliminated (France, Mexico, Philippines, Ecuador, Norway). These qualifications might refer to the nationality, the professional background or to policy decisions.

It may also happen that an environmental impact assessment is required (Malaysia, Sri Lanka, Indonesia) and with the result that a series of other documents have to be prepared by the applicant.

However, factors such as duration, cost and renewal of authorizations are likely to enhance or to limit the development of aquaculture. Indeed, potential fish farmers will be more attracted by a regime including low costs, fiscal incentives, long duration and/or automatic renewal, etc.. For instance, a short duration of the authorization and discretionary powers of the granting authority could prove to be an obstacle to the development of the aquaculture sector. From the countries examined, it appeared that aquaculture authorizations last from a minimum of 3 years to 25 years with some exceptions like Singapore (1 year), France (35 years), Switzerland (normally unlimited). Crucial could be the cost of obtaining the authorization. Authorizations are usually renewable under similar terms and conditions on which the first was granted. Exceptionally, in some countries (Cyprus, U.K.), applications for renewal are considered on their merits and conditions and terms may be altered.

It is thought that ideally, there should be the capability of imposing conditions on the aquaculture activity which should cover the following: the areas in which aquaculture may be undertaken (Cyprus); the structure, equipment and maintenance practices to be used (Rep. of Korea, Hong Kong); the species which may be introduced into a particular aquaculture facility; the composition of feed and/or quantity that may be used (Denmark, Finland, Sweden, Greece, Netherlands); the control of the use of pharmaceutical preparations, drugs or antibiotics (U.K., Hungary, Norway, Canada); the notification of diseases, disposal of dead fish, the movement of aquatic species; the monitoring and control of water quality; insurance of aquaculture facilities; maintenance of records and their content; the disclosure of information concerning aquaculture activities (Cyprus); the period or periods within which conditions must be fulfilled; and the changes in structure, equipment, maintenance practices.

Finally, where an authorization system is provided for, an offence is committed by failure to obtain such an authorization. Thus, many laws and regulations provide for the possibility to enter and inspect facilities, for criminal prosecutions and administrative remedies such as cancellation, refusal to renew etc,.

Aquaculture and environment: a brief overview of existing legal controls

The concern regarding the environmental impacts caused and suffered by aquaculture is increasing. In fact, sound reasons exist why aquaculture ought to be environmentally regulated in its own interest and the interest of others affected by the activity. Aquaculture cannot be isolated from the wider environment in which it functions. Among environmental concerns that countries consider affecting the development of aquaculture, emphasis is put on pollution by domestic and other industrial wastes and on pesticide pollution (point and non point source pollution). On the other hand, aquaculture is apt to have adverse impacts on the environment.

In relation to the former concern (impacts suffered), the development of aquaculture appears to bring with it two major legal (and policy) issues: conflicts between competing water/land uses, and water quality and quantity. The legal framework of most countries reviewed provides means of preventing or curing the problem. However most of them are still built around traditional zoning and land use planning laws and regulations or around recently enacted environment protection related legislation, and thus not particularly specific to aquaculture. Nevertheless, some governments contribute significantly in protecting coastal water quality upon which marine/brackish water aquaculture operations rely (Hong Kong, Ecuador, Republic of Korea, France) through the designation of protected areas for the purposes of aquaculture (Republic of Korea), the creation of buffer zones around aquaculture activities within which certain developments (e.g. industrial) may not occur (Ecuador, Ireland, Norway), or government planning of coastal activities along a coastal zone management plan (Sri lanka, Thailand, France). Other countries have enacted pollution control laws and regulations which aim at protecting the water quality in the interest of propagation and protection of fish and/or aquatic life (China, Malaysia, Bangladesh).

Interestingly, very few countries have provided remedies for the main concern of the aquaculturist i.e. to be entitled to compensation for having suffered an

injury to his activity due to environmental changes (Rep. of Korea, Hong Kong).

Where aquaculture is likely to cause adverse impacts, the legislation of several countries provides legal tools which are intended to prevent them from occurring. The provision of an authorization procedure for setting up and operating an aquaculture farm may constitute a good basis for ensuring that the farm will be managed in an environment-friendly manner. Further, aquaculture development is made subject to public controls over land use, site selection, coastal area management, wetland use, pesticide use controls, food laws and sanitary regulations. They aim at avoiding competing land and water uses, water quality alterations (problem of disposal of effluents and management of the sources of waste) and at securing a healthy and marketable product. Increasingly, the use of environmental impact assessment procedures is intended to allow for preventive measures to be formulated before the aquaculture activity starts.

To summarize, the studies evidenced that most countries relied on preventive measures to avoid harm and reduce or eliminate the risk of harm caused by aquaculture. They include (i) setting of standards, (ii) restrictions and prohibitions, (iii) licensing, and (iv) environmental impact assessment. One of the main legal problems is caused by the fact that most of these preventive measures were exceptionally aimed at controlling the aquaculture development as a potential polluter. For example, the water quality standards are often set according to beneficial uses of the aquatic area i.e. the preservation of fish life but not particularly for aquaculture purposes. The lack of value the public places upon aquaculture relative to residential developments, water quality, habitat alterations, commercial fishing and other competing uses of public resources may also contribute to increasing these problems. Little attention is given to the various economic incentives and disincentives which are likely to affect conduct towards the environment and could induce change in behaviour or produce revenues to finance aquaculture environment policy programs. It became also apparent that monitoring of compliance and enforcement are an area of great concern to the governments because they are critical to the effectiveness of all manner of legal prescriptions. As pointed out at the beginning of this paper, these matters will be dealt with in a subsequent paper.

Conclusion

The point can be made here that the aquaculture activity has increased in importance in many countries but that this importance is often not reflected in the legal regime governing aquaculture. The studies evidenced on the one hand that the legal needs of aquaculture are not always met and a better understanding and awareness ought to be created among those involved in drafting relevant legislation of how aquaculture operations need to be legally organized. On the other hand, it has become clear that where possible countries should work towards aquaculture specific legislation because it has its own needs and concerns which are not always properly addressed if the subject is treated merely as an appendage of other areas. This is also very important in respect of the legal regime for the environmental management of aquaculture, as the activity of aquaculture raises specific issues not adequately covered in general environmental protection legislation. Also, in the near future, the Aquaculture Steering Committee of the Fisheries Department should look into the legal implications of the present definition of aquaculture.

Notice of Meeting

The Seminar on African Inland Fisheries, Aquaculture and the Environment has been rescheduled to take place in Harare, Zimbabwe, from 5-7 December 1994, as part of the Ninth Session of the Committee for Inland Fisheries of Africa (CIFA), which will take place from 5 to 9 December 1994. Information on this seminar can be obtained from K. Remane, Technical Secretary of the seminar, FAO, Fishery Resources and Environment Division (FIR), via delle Terme di Caracalla, 00100 Rome, Italy, Fax: 39-6-52253020, Tlx: 61081 FAO I., E-mail: katja.remane@fao.org, or from W.Q.B. West, Secretary of CIFA, FAO, Regional Office for Africa (RAFR), PO Box 1628, Accra, Ghana, Fax:233-21-668427, Tlx: 2139, E-mail FAO-RAFR@CGNET.COM.

FISH CULTURE IN LAND-LOCKED LAO PDR

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Background

LAO Peoples Democratic Republic (LAO PDR) is a land-locked country, 80 % of it is mountainous and over half of the country is between 1,000- 2,000 m high. The country has vast fishery resources. The main capture fishery resources are in the Mekong river with its 14 major tributaries and in the major reservoirs like Nam Ngum, Nam Souang, Nam Houm, Nam Tan, Selabam, Nam Dong, Nam Moun etc. The capture fishery production has been declining over the years due to over-fishing and lack of management. There are large number of village ponds of varying sizes with an estimated total area of 8000 ha and vast areas of rice-fields (irrigated and rainfed), some of which are suitable for the development of fish culture.

LAO people like fish in their daily diet. Fish production in 1993 was estimated at about 30,000 tons, in which aquaculture contributed about 12,000 tons. However, the national average fish consumption is only around 7 kg/caput/year. As a result, the overall diet of LAO population particularly in the remote villages is unbalanced, rich in carbohydrate and poor in protein. The country is sparsely populated with about 4.3 million people in 236,803 sq km area, where the road, water and air communications are very difficult. Under these circumstances, promotion of aquaculture was found to be the most pragmatic approach for producing quality fish in the rural areas to improve the diet and income of the village population.

Status of aquaculture

Aquaculture development in Laos started with construction of several fish farms during 1956-1975 under the USAID programme. This activity was later supported by the Mekong Committee by upgrading an existing fish farm at NongTeng (Vientiane), and by constructing a 50 ha commercial fish farm at ThaNgone. During the period 1978-1988 two FAO/UNDP projects (LAO/78/014 and LAO/82/014) gave a big boost to aquaculture development by rehabilitating the existing fish farms and by developing an additional one and thus covering 6 provinces in Laos. These modern fish farms helped in developing efficient, low-input technologies for market fish production mainly by integrating fish culture with livestock and crop production systems. The ongoing project LAO/89/003 on fish culture extension started in April, 1992 with the main objectives of transferring fish culture technologies to the rural farmers with a view to improving their nutritional status and economic conditions.

Aquaculture in Laos is slowly becoming an integral part of most of the rural development programmes; and ponds are considered useful not only for fish production but also for water storage for agriculture and livestock.

Development Approach

Due to acute shortage of trained manpower, the most appropriate approach adopted by the government is to identify and support the 'Model Farmers' who are progressive in attitude and are ready to serve as village level extensionists or 'Change Agents'. These 'Model Farmers' are selected from the project's Target Farmers (TFs) who are usually the leaders in the community. These TFs are provided with technical guidance on one hand and administrative support through district level administration on the other hand. This way demonstration sites for various aquaculture farming systems have been developed to serve as sites for technology testing and development of appropriate aquaculture technologies for the different agro-climatic zones of the country and for the farmers belonging to different socio-economic strata. The main aim of the national policy is to gradually upgrade the subsistence level aquaculture to commercial level to meet the demands of the domestic markets.

The step by step approach followed by the project is summarized below:

Step 1:Before the start of the project, a Rapid Rural Appraisal (RRA) was conducted by the national staff in 10 provinces (Vientiane Prefecture, Savannakhet, Xiengkhouang, Borikhamxay, Saravanne, Champassak, Xayabury, LuangPrabang, Oudomxay and Houaphanh) to identify the likely Target Farmers (TFs) in the districts recommended by the provincial administration. Altogether 112 farmers were interviewed of which 61 farmers were considered as possible TFs.

Step 2 :In the first year, 3 main centers, one each in Vientiane, Savannakhet and Xiengkhouang, were established. An Orientation Workshop was held in June-July, 1992, and the counterparts from 10 provinces were invited to discuss the strategy of the project and to build a close contact with the project team.

Step 3 :The project team (national and international) carried out field visits to the TF's and classified them as most progressive farmer (category A), enthusiastic farmer (category B) and interested farmer (category C), depending on the degree of experience and interest shown in fish culture. On receiving extensive training for 2 years the TFs graduated from category C to B and then to A, and finally 24 farmers from category A were selected as Model Farmers. The ponds of these Model Farmers are being used as demonstration ponds for training other farmers in the neighbourhood. The 24 Model Farmers are demonstrating 4 farming systems in 39 sites as shown in Table 1. Each of these 24 Model Farmers are expected to train 10-15 neighbouring farmers. Some basic project inputs like fish fingerlings, piglets, chicks and ducklings, netting materials, hapas, hormones etc. were supplied free of cost to TFs (only one time supply). Technical support was provided to all the TFs through regular monitoring visits and training courses.

Table 1. Demonstration of Farming Systems

Farming systems

The following farming systems have been adapted and demonstrated by the project:

Polyculture and integrated culture systems

Under this culture system the ponds are dried, limed and manured. The stocking is done mostly with common carp, Indian carp (rohu & mrigal) Chinese carp (silver/bighead) and local species depending on availability. In addition, the use of Nile tilapia is a common practice. However, stocking density is maintained between 3000-5000/ha with ratio of 4: 2:4 of surface, column and bottom feeders respectively; plus some grass carp, if available. The ponds are regularly manured and the fish are fed with rice bran. In small family ponds, common carp and tilapia are grown, manured by pig dung/chicken droppings and fed mostly with rice bran and kitchen wastes. Generally the farmers follow continuous harvesting practice. The livestock are housed mostly over pond embankment with the house partly stretching over the pond. The common livestock used are pigs, chicken and ducks.

Rice cum fish culture system

In this system, farmers construct a small pond inside or adjacent to the rice field from which the fingerlings or growing fish enter into the rice field. Trench construction inside the field is encouraged by the project and is receiving good response from farmers. The species grown are mostly common carp, tilapia, *Puntius* spp, *Trichogaster* spp and various locally available species. In areas with warmer climate even mrigal, silver carp and big head carp are added in small numbers. The suitable rice fields are those which have irrigation water supply or flowing water supply from perennial streams. The depth of water maintained in the field varied from 10 to 15 cm. Recently, farmers

Province	Farming systems			
	Polyculture	Integrated fish -livestock culture	Rice + fish culture	Seed production
Vientiane Pref.	4	1	6	2
Savannakhet	6	2	6	-
Xiengkhouang	2	4	6	-

are getting interested in growing 2 crops of fish, one with rice and the other of fish alone after the rice is harvested. The duration of culture varies between 90-120 days and supplementary feeding is minimal and not very common. However, farmers are advised to feed the fish.

Seed production system

Farmers generally breed common carp, tilapia and *Puntius gonionotus*. It is a highly profitable business and a means for quick income generation. Some farmers purchase the hatchlings/early fry and rear them to fry/fingerlings for their own use and for selling to other farmers. The project is training the Target Farmers on selection and maintenance of broodstock, breeding and rearing of fry/fingerlings.

Results

The project is only half way through its life and within the last two years the project has succeeded in bringing 50 ha of polyculture, 20 ha of integrated culture and 80 ha of rice-fish culture under its direct supervision. Within the project target areas fish production has increased by 2-4 folds. Production from polyculture has increased from 50-800 kg/ha/yr to 200-2000 kg/ha/yr. and in rice-fish culture from 50-150 kg /ha/yr to 100-600 kg/ha/yr. With experience, the rate of fish production is expected to increase further.

So far, 563 farmers including 24 Model Farmers and 27 government officials have been trained on various aspects of fish culture and fish culture extension methodologies.

Discussion among farmers during training programme in target village

The author wishes to acknowledge with thanks the cooperation and support of the national and international staff of the project.

Harvest of fish from rice field

NEWS ITEMS

Dr. A.J. Tacon attended a National Seminar-Workshop on "Fish nutrition and feeds" held in Iloilo, Philippines from 1-2 June 1994 and presented a paper on "Feed formulation and evaluation for semi-intensive culture of fishes and shrimps in the tropics".

The aim of the seminar-workshop was to bring together aquaculture nutrition researchers, government officials, aquafeed manufacturers, and fish/shrimp farmers to discuss and exchange information on feeds for small-scale aquaculture, and to identify priority areas and recommend strategies for future research on fish feed development, focusing on technologies that are appropriate for developing countries, particularly the Philippines.

Approximately 140 participants from seven countries (Brazil, Germany, Indonesia, Italy, the Philippines, Thailand, and the USA) attended the seminar-workshop. The meeting was divided into two consecutive sessions, the first dealing with advances in fish nutrition research and the second dealing with feeds and feeding management. A total of five plenary lectures/review papers, 11 research experience papers, and 14 poster papers were presented. In addition to the papers presented, two workshops were held; a workshop on 'Nutrient Requirements, Feed/feedstuff Digestibility, Standardization of Fish Nutrition Research Methodologies' (at the end of the first session) and a workshop on 'Farm-made Feeds for Milkfish, Seabass, Shrimps, Tilapia, Carp and Catfish' (at the end of the second session).

The seminar-workshop was successful in that it brought together both research scientists, government legislators, aquafeed manufacturers and fish/shrimp farmers under the same roof to discuss issues related to the formulation, manufacture and on-farm use of compound aquafeeds by small-scale farmers. In particular, the workshops highlighted the central role played by farm-made aquafeeds within semi-intensive farming systems in Asian countries and the need to maximize the nutritional benefit gained by the cultured species from endogenously produced natural pond food organisms and minimize exogenous supplementary feed inputs. Emphasis was placed on the ability of supplementary feed-based semi-intensive feeding strategies to utilize locally available agricultural by-products and wastes (in contrast to commercial-based complete diet feeding strategies) and by so doing reducing feed and farm production costs for the small-scale farmer. The workshops discussed the different methodological approaches for the measurement of dietary nutrient requirements and ingredient/feed digestibility, and stressed the need for conducting such trials under conditions mimicking as far as possible those of the intended farm production unit (ie. nutrition studies for pond-reared, cage-reared and tank-reared fish/shrimp should be conducted within experimental ponds, cages and tanks, respectively). Dr. Tacon stressed the need of the aquaculture sector to reduce its dependence on fishmeal and other fishery resources, and the need of the small-scale aquaculture producer to culture herbivorous/omnivorous fish/shrimp species feeding low on the aquatic food chain which require only minimal feed inputs and which have the ability to utilize to the fullest naturally available pond food organisms and 'sustainable' plant-based feed ingredient sources.

Dr. A.J. Tacon attended a seminar on "The Management of Integrated Freshwater Agro-piscicultural ecosystems in Tropical Areas" held in Brussels, Belgium from 16-19 May 1994. The Seminar was jointly organized by the Royal Academy of Overseas Sciences (ARSOM, Belgium), The Technical Centre for Agricultural and Rural Cooperation (CTA, Wageningen, The Netherlands) and FAO. The aim of the seminar was to review the status of integrated agriculture-aquaculture ecosystems in Asia and Africa, with a view to identifying the best possible avenues of research and development of aquaculture within Sub-Sahelian African countries.

Approximately 150 participants from 32 countries (including 18 African countries) attended the seminar and a total of 29 papers were presented.

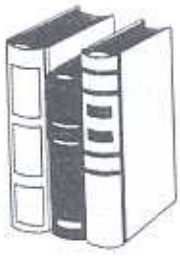
Dr. Tacon presented a paper entitled "Semi-intensive feeding methods for freshwater fish: concepts and research approaches". The seminar highlighted the role played by integrated agriculture-aquaculture farming systems in Asia and concluded that if such farming systems were to succeed within Sub-Sahelian countries, many socio-economic and technical issues would have to be addressed.

A seminar on the Management of Integrated Freshwater Agro-Piscicultural Ecosystems in Tropical Areas was held in Brussels, Belgium from 16-19 May. With the cooperation of FAO, the seminar was organized by the Belgian Royal Academy of Overseas Sciences and the Technical Centre for Agricultural and Rural Co-operation of the Netherlands. The main objective of the Seminar was to survey/review the state of the art of integrated agro-piscicultural ecosystems in Asia and in Africa with a view to making recommendations for the adaptation of the related technologies in Africa. Dr. J. Kapetsky of this Service presented a paper in which he used the GIS for warm water fish farming in Africa to establish geographic limits on warm water fish farming potential in ponds. Then, using a constant per caput fish supply as a benchmark, he measured the assumed growth of fish farming for the period 1996 to 2000.

The results suggest that, even with accelerated development of subsistence fish farming, many countries still would face a large shortfall in fish supply by 2000. In some countries even the rapid development of commercial fish farming alongside subsistence farming probably could not make up the fish supply deficit by 2000. In other countries the rapid expansion of subsistence fish farming could reach limits imposed by high demands on land for ponds.

[Further information can be obtained from J. Kapetsky, FIRI, FAO, Rome]

NEW PUBLICATIONS



The volume No.24 in the *FAO Training Series, entitled* "Handbook on small-scale freshwater fish farming" is out of press and is now available from the Sales and Distribution of FAO Headquarters. This handbook provides a wealth of simply presented and illustrated information on freshwater fish farming in ponds, pens and cages, compiled from five booklets published on the subject in FAO's Better Farming Series between 1979 and 1990. Here in an improved format, particulars of pond, pen and cage location, construction and management are covered in outlines that can be modified to suit local conditions. The handbook is primarily intended to help workers, technicians and teachers present their knowledge of freshwater fish farming to small-scale farmers. For example, it can be used as a trainers' aid in conjunction with the five original booklets, which can be distributed among trainees. The handbook ends with a set of questions that could be used to test the trainees' comprehension.

A.G. Coche et J.F. Muir. Pisciculture continentale; **Les étangs et leurs ouvrages;** ouvrages et agencement des fermes piscicoles, dans la collection *FAO: Formation ; méthodes simples pour l'aquaculture N. 20.2.* Le présent ouvrage est le quatrième manuel (comprenant deux volumes, 20/1 et 20/2) à être publié dans la Collection FAO: Formation sur les méthodes simples pour l'aquaculture. Il traite des aspects pratiques de génie civil appliqués en pisciculture d'eau douce. Dans le volume précédent, vous avez appris ce que sont les caractéristiques générales des étangs de terre et des fermes piscicoles, comment choisir leur emplacement, comment utiliser divers matériaux et équipements, comment préparer le site choisi et comment construire différents types d'étangs. L'étude du présent volume doit vous apprendre à concevoir et à construire de simples ouvrages pour le transport et le contrôle de l'eau d'une ferme piscicole. Vous y apprendrez également comment protéger votre ferme de l'inondation et de l'envasement. Enfin, vous apprendrez à planifier au mieux la construction de votre petite ferme piscicole.