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SOME NOTES ON AQUACULTURE DEVELOPMENT
IN THE SOUTH PACIFIC

by

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I. Background of FAO South Pacific Aquaculture Development Project

In the past, aquaculture has often been tried, with indifferent results. However, as capture fisheries have sometimes affected inshore and reef fisheries resources there is a case for renewed efforts in aquaculture, primarily to encourage productive industry and also to help recover from overexploitation.

The present project, which started in December 1986, aims at assisting governments in establishing and developing economically sound and socially viable aquaculture industries in their countries. It is funded through the Government of Japan with the amount of US\$2 million for a five-year period. The project is based in Fiji and serves 15 countries in the region.

II. Present Situation and Trend of Aquaculture Activities in the Region

The current situation of aquaculture activities by species in the region is briefly tabulated in Table 1.

From the economic point of view, it seems that Eucheuma culture is most feasible aquaculture among current activities in the countries associated with this project ("Project countries"). All production of Eucheuma is exported. Many countries are planning to develop this industry. However, the number of buyers are limited and it is anticipated that the price may fall if these schemes lead to overproduction in the future. The FFA has recently completed a Eucheuma marketing survey in the Philippines for expanding marketing channels and for improving product processing.

Stocking practices of giant clam in lagoon space have rapidly spread in almost all of the countries served by the ~~the~~ MMDC from Palau. These are mostly at experimental level and small scale at present. The stocks generated from this work might be used as breeders in the future. In Yap State of the Federated States of Micronesia, 8,000 clams were distributed into 31 villages around the coast of Yap Island. They are maintained by village people. If all clams were to start spawning simultaneously in the lagoon it would help to sustain reef resources. Only one large-scale giant clam farm in the Marshall Islands is commercially operated in the

region at present. All the seed was locally produced there and 28,000 clams have now been stocked in tanks and the lagoon. This farm is still investing for expansion.

Other major species cultured commercially for domestic or export in Project countries are black-lip pearl shell in Fiji and Cook Islands, marine shrimp in Fiji, freshwater giant prawn in Solomon Islands and crocodile in Papua New Guinea. Of those species, black-lip pearl shell culture is attracting a great deal of attention in the region.

Some freshwater aquaculture farms are also commercially operated in high islands but those are generally at small scale and subsistence level such as the culture of Tilapia (Nile Tilapia) in Fiji, freshwater giant prawn in Palau and Western Samoa, and common carp and trout in Papua New Guinea.

Transplantation and re-stocking of Trochus in reef areas are being undertaken in Cook Islands, the Federated States of Micronesia and Tokelau for increasing productivity of reef and for sustaining reef resources. Cockle transplantation has been also tried in tidal sand on atoll coasts of Kiribati. Green mussel has attracted interest for high island countries such as the Federated States of Micronesia, Fiji, Vanuatu and Western Samoa, exploiting lagoons or small bays as culture grounds.

Milkfish is being cultured on a large scale by Kiribati Government mainly to supply bait fish for their flourishing pole-and-line fishery. However, demand for milkfish as food fish is increasing at home as well as in neighbour countries possibly because of declining reef resources caused by overexploitation. Milkfish which is widely distributed in the region has been traditionally stocked in various lakes and blocked lagoons. These traditional practices, however, encountered difficulties when those waters became infested with Tilapia. Milkfish culture is now reviving in those lakes and many other countries such as Cook Islands, the Federated States of Micronesia, Kiribati, Nauru, Palau, Tonga and Tuvalu, are also showing interest in milkfish stocking and culture.

New species of seaweeds, ornamental shells, sponges and coconut crab are expected to have greater aquaculture potential in the region in the future.

In non-Project countries in the region such as French Polynesia, Guam, Hawaii and New Caledonia, emphasis is on developing intensive aquaculture, for instance, marine shrimp in French Polynesia, Hawaii and New Caledonia, sea-bass in French Polynesia, Mahimahi, abalone and algae in Hawaii etc. In those islands, technologies as to seedling and feed production are well developed. However, profitability of intensive

aquaculture in those islands are generally not fully confirmed as yet in spite of continually increasing investment.

Although many Pacific islands have taken Hawaii as a model of aquaculture development in object species as well as culturing methods in the recent past, this trend is fading as Hawaii has been turning her interest from tropical to the more intensive subtropical aquaculture, possibly related to the recent sharp development of international tourism in Hawaii. Thus, the aquaculture trend in the region is now changing to seek more originality in development in the region.

III. Scope of Aquaculture Development in Pacific Islands

Objectives of aquacultural production undertaken in the region by group of countries are described in Table 2. A group of non-Project countries: French Polynesia, Guam, Hawaii and New Caledonia are generally recognised as international tourist areas of long standing. The table shows an obvious difference of objectives between two groups. In (most) Project countries, it is apparent that aquaculture for food production is given low priority. On the other hand commercial food production for domestic consumption is the main object of aquacultural production in the group of tourist-oriented countries. However, their common export items are non foodstuffs. They are either industrial material or high-value accessory.

In consideration of the present situation in the region, the following types of aquaculture development might have good prospects in most of the Project (non-tourist) countries.

1. Development for Export

It seems that some Pacific island countries have so far followed in the wake of another islands' interests in aquaculture development simply because of similarity of climatic and geographic features. This is similar to the progress of agriculture development in the region. In fact, however, the surroundings are quite different between high islands to atolls. Therefore, object species could be properly selected by each island. This will be helpful to mitigate marketing competition for export items.

Since, from the trading point of view, aquaculture species that are valuable in international markets are currently limited in the region and each country has similarity in component of aquaculture species, uneasiness overlays marketing aspects, in e.g. pricing competition, fear of overproduction etc, as occurred in passion fruit. It consequently will be essential to increase the variety of species to help overcome this problem.

If it is desired to develop exportation through aquaculture activities, the following must be taken into consideration;

- (1) To produce a speciality by taking advantage of unique features of each island, or
- (2) To produce either dryable items to lower shipping costs or high-value items to cover high freight costs.

Production of tourist souvenirs and their exportation to tourist islands in the region might be one possibility.

Species deserving consideration other than Eucheuma and black-lip pearl shell would be Beche-de-mer, sponges, seaweeds for chemical extract, ornamental shells, coconut crabs, high-value reef fish or shellfish, land hermit crab as fishing bait, etc.

2. Development of Domestic Food Production

In Project countries, aquacultural production of high-value food generally is not likely to be feasible even in the foreseeable future, due to lower purchasing power. For general public consumption, semi-intensive pond culture of freshwater giant prawn, Tilapia, milkfish, etc, might be encouraged in high islands. However, constraints of pond management and in preparation of feed and fertilizers would have to be overcome. It is feared that aquaculture generally competes with agriculture particularly in low island countries which have limited land. Since areas suitable for inland water aquaculture is usually good for agriculture and land tenure is sometimes an obstacle for development, due consideration should be taken into account in planning.

Exploitation of lagoon or bay as culture grounds of shellfish such as green mussel, which requires no artificial feeding, will be attractive in future, although sea tenure is also a constraint in some countries.

3. Development of Bait Fish Culture

This development might be encouraged for supporting a stable fishing industry. Milkfish is a preferable bait not only for pole-and-line fishing but also for long-line fishing. For making stabilized production of bait fish in quantity and in quality some supplemental research and experiments are required at present for further improvement.

4. Development of Subsistence Production

Subsistence aquaculture could best be developed mainly in inland waters. Although inland water area is limited in the region, it could be significant in terms of promotion of import-substitution. There are two types of practice to be recommended in this field: pond culture in high islands and stocking of mullet and milkfish in some of the numerous, large lagoons and lakes, that are scattered throughout both high and low islands.

Integrated fish farming with poultry or piggeries would enhance pond culture, and it is suggested that village and school farming development schemes may be appropriate means for promoting construction of ponds or reservoirs in rural areas.

Since traffic between main island and smaller, outer islands is often interrupted during monsoon period, whilst fishing is restricted at the same time due to rough weather, food security can become critical during this time in some outer islands. For this reason, fish stocking programmes in outer island waters would be most valuable. It could also, possibly help reduce depopulation of outer islands.

5. Development of Reef/Lagoon Stocking

As a measure to counter declining reef resources, transplantations of *Trochus* and stocking experiments of giant clam are at present being undertaken in each country of the region. Since natural resources of giant clam especially, are declining sharply, considerations of some urgent counterplans are currently required. The method for maintaining and increasing this resource is not established as yet, whether seed should be released to reef from the hatcheries to be established at each country or whether natural propagation should be awaited like the "Yap method". In recent market trends there appears to be valuable export potential even for young giant clam. The method and type of giant clam culture will change in adaptation to future market demands.

The most important matter for sustaining reef resources will be their management and the protection of breeding. Reef resources were traditionally controlled through village communities. However, those controls are often relaxed due to the recent increment of population, changes of communal society etc, which has led to the present decline of resources. In order to avoid overfishing, it is essential to establish fishing regulation, particularly of fishing period, fishing areas and capture size by species with strict control of explosive and chemical fishing. To be successful, this must of course, be explained to and accepted by fishermen and the general public. In addition to this, further action is needed to accelerate the natural breeding of important fishery species and to keep released seed away

from predators, for instance, settlement of artificial shelter etc, would be beneficial in the long term.

To increase production from the reef/lagoon, propagation or stocking of species other than giant clam and Trochus, such as Beche-de-mer, cockles, green snail and other large molluscs, edible seaweeds etc, could usefully be examined.

IV. Constraints and Approach

The broad purposes of the aquaculture industry development will be of diversifying the supply of aquatic products to nationals, generating employment opportunities, increasing foreign exchange earnings and improving the management of the environment. However, in order to fix aquaculture as a part of the industry of the country, it would be useful to establish a certain measure of social and economic infrastructure. As aquaculture is essentially a form of agriculture, there are difficulties encountered in development of the aquaculture industry in Pacific island countries where such social and economic infrastructure and agricultural foundations are generally not substantial and farm management method is still in its infancy. Many development projects in the region encountered farm management problems in the past.

The most interesting object species for aquaculture in the region are currently Eucheuma and giant clam. The points of similarity in their culturings are :

- (i) they grow naturally without feeding,
- (ii) they grow in open space of reef or lagoon e.g. no need to construct any enclosure or pond and
- (iii) their culture methods are simple and rearing management requirements are minimal.

In consideration of findings and constraints as mentioned above, aquaculture development in the region could best be carried out at extensive rather than intensive level with consideration of applicability of islanders' traditions, preferably in the reef or lagoon due to ease of access. Reefs and lagoons lend themselves particularly to three dimensional aquaculture i.e.: at different depths utilizing different ecological niches.

Tropical ocean water is generally poor in nutrients and accordingly sustainable productivity is low. However, seaweed, shellfish and probably Beche-de-mer grow well even in low nutrient waters. More suitable species which have fishery value and grow easily in such condition could be determined in the future if detailed studies were to be carried out in the fields of reef or lagoon, especially in atolls. The best way to exploit the natural productivity extensively for fishery

production purpose with minimum management will be the introduction of the concept of "ranching". This may be called Reef/lagoon ranching. The study and identification of the significance of Reef/lagoon ranching will be a main subject in the project.

Since there is at present scanty knowledge on the ecology of organisms living on reef/lagoon, which is a basic study prior to development of oceanic islands aquaculture, it is suggested that research and studies in this field be promoted. For this purpose bilateral cooperation agencies, international research organizations, university institutes etc, will be sought.

Table 1. Aquaculture activities by species in Pacific region

Species	Group ¹⁾	Country	Management	Purpose	Scale	Method ²⁾	Economic ³⁾ efficiency
I. Algae							
a. Eucheuma (seaweed)	A	Cook Is. Fiji FSM Kiribati Tonga	government private private private private	experiment export export export export	small extended small small small	E E E E E	x o x + +
b. Gracilaria (seaweed)	B	French Poly. Hawaii	private private	experiment local	small small	E E	+ -
c. Spilurina (blue-green algae)	B	Hawaii	private	local & export	medium	I	-
d. Dunaliella (unicellular algae)	B	Hawaii	private	export	small	I	-
II. Molluscs							
a. Giant clam	A	Cook Is. Fiji FSM, Yap FSM, Others Marshall Is. Palau PNG West. Samoa Amer. Samoa	government government government government private government government government	experiment experiment reef stock experiment export & local experiment export & reef stock experiment experiment experiment	small small extended small large small large small	E E E E E E E E	x x x x x self seedling x + self seedling x x x
b. Trochus	B	Guam Hawaii Saipan	- - government	experiment experiment experiment	small small small	E E E	x x x
	A	Cook Is. FSM Tokelau Vanuatu	government government government government	reef stock reef stock reef stock experiment	small small extended small small	E E E E E	x x x seedling only
d. Green mussel	A	Fiji	government	experiment	small	E	x
	B	French Poly. New Caledonia	government private	local local	large extended	E E	+ self seedling -
e. Abalone	B	Hawaii	private	local & export	small	I	- newly started
III. Crustacean							
a. Freshwater giant prawn	A	Fiji Palau	government private	experiment local	small small	S -	x self seedling -
	B	Solomon Is. West. Samoa French Poly. Hawaii New Caledonia	private private private private private	local local local local local	medium small medium extended large	I I I I I	seedling only - - + seedling only + seedling only
b. Marine shrimp	A	Fiji Solomon Is.	private private	local & export local & export	large medium	S S	seedling only newly started self seedling newly started
	B	French Poly. Hawaii New Caledonia	government private private	experiment local local	small small large	I S I	x self seedling newly started newly started self seedling + self seedling +
c. Coconut crab	A	Vanuatu	government	experiment	small	E	x
IV. Finfish							
a. Milkfish	A	Kiribati	government	local & export	large	E	+
	B	Guam Hawaii	private private	local experiment	medium small	I I	o seedling only
b. Mullet	A	Tonga	government	experiment	small	E	newly started
	B	Hawaii	private	local	small	I	seedling only
c. Tilapia	A	Fiji	private	local	small	S	+
	B	Guam Hawaii	private private	local local	medium extended	I I	o o
d. Chinese carp	A	Fiji	government	river stock	medium	S	x self seedling
	B	Guam	private	local	small	I	newly started
e. Common carp	A	PNG	private	local	small	E	x
f. Trout	A	PNG	private	local	small	S	x
	B	Hawaii	private	local	small	I	-
g. Rabbitfish	A	FSM, Yap	private	local	small	E	newly started
h. Mahimahi	B	Hawaii	private	experiment	small	I	x
i. Sea-bass	B	French Poly.	government	experiment	small	I	x
j. Catfish	B	Guam Hawaii	private government	local stock	- small	I I	- seedling only
V. Others							
a. Sea-turtle	A	Palau	government	release	small	I	seedling only
b. Crocodile	A	PNG	private	export	small	I	-
c. Frog	B	Hawaii	private	local	small	I	newly started

Note: 1) Group A: Project countries
B: Non-Project countries
2) Method E: Extensive
S: Semi-intensive
I: Intensive

3) Economic efficiency o: Profitable
+: Break even
x: Unprofitable
-: Not available

Table 2. Aquaculture production by objective in Pacific islands.

Objective	Project countries	Non-Project countries [*]
A.Export	Eucheuma, Crocodile	Black-lip pearl shell
B.Domestic a.High-value food b.Public consumption c.Non-food	Marine shrimp Freshwater giant prawn Milkfish (for bait fish)	Marine shrimp, Abalone Green mussel, Spirulina Tilapia, Milkfish, Freshwater giant prawn, Catfish, Trout, Gracilaria
C.Subsistence	Tilapia, Carp	
D.Stocking/ release a.Reef/ lagoon b.Inland waters	Giant clam, Trochus, Sea-turtle Chinese carp (for weed control)	Catfish (for game fish)

* French Polynesia, Guam, Hawaii and New Caledonia