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Shrimp pond culture in the Philippines

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Shrimps and prawns have become a multimillion dollar industry in the Philippines with exports (mainly to Japan) increasing from 179 t valued at US$149,000 in 1968 to 30,460 t worth $273 million in 1991. Asian countries contributed 80% of the worldwide production of cultured shrimps totalling around 690,100 mt in 1991. Ecologists, however, have warned aquaculturists regarding the effects of the industry's growth on coastal pollution.

Of the total 1991 aquaculture production of 692,400 mt, 42% comes from fish and shrimp yields in brackishwater ponds, and 13% from freshwater ponds, pens, and cages and the rest from seaweeds and mollusc culture in marine waters.

History of brackishwater pond culture

The beginnings of brackishwater pond culture in Southeast Asia can be traced to either the islands of Madura or East Java in Indonesia almost 600 years ago. The first recorded fishpond in the Philippines was in Rizal Province in 1863, the culture spreading out around the Manila area for at least half a century.

Milkfish monoculture was introduced first at low, followed by increasingly higher densities. In the Philippines, the major cultured shrimp species is the giant tiger shrimp (*Penaeus monodon*). Its production has steadily increased from 1,400 t in 1980 to 47,600 t in 1990, whereas the yearly marine catches from 1968 to 1987 fluctuated between 10,000 and 40,000 mt, with an average of around 24,000 t. In 1989, semi-intensive and intensive ponds produced over 65% of the total *P. monodon* harvests.

Shrimp culture systems

As with other aquaculture systems, shrimp grow-out farms may be classified into four categories - traditional, extensive, semi-intensive, and intensive - characterized by increasing stocking rates supported by corresponding feed and water management inputs.

Comparative economic analysis

The primary motivating factor behind the shift of traditional milkfish and shrimp farmers to intensive shrimp culture, is greater profitability. The assumption of more profits can be verified by looking at the comparative economics of the different culture systems.

Intensive farming is characterized on a per kilogram basis by low fixed cost because of high productivity per area, but high variable cost mainly for feeds and water quality maintenance. Profitability depends on market price and production costs. If market prices are favorable, intensive farming remains profitable from the sheer volume of production; once prices drop, so does profitability. Semi-intensive farms will survive because of relatively higher productivity at lower production costs. In 1988, B. Posadas found that

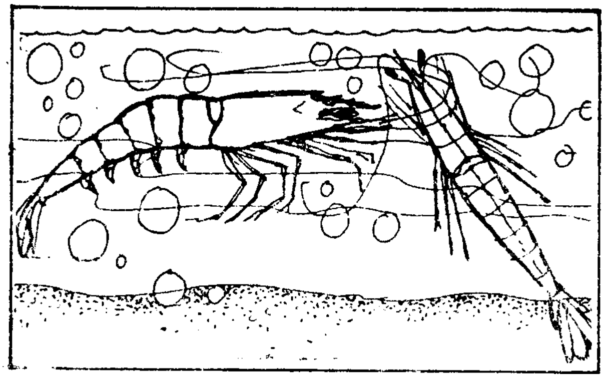
Table 1. Economic comparison of extensive, semi-intensive, and intensive shrimp farms in Indonesia

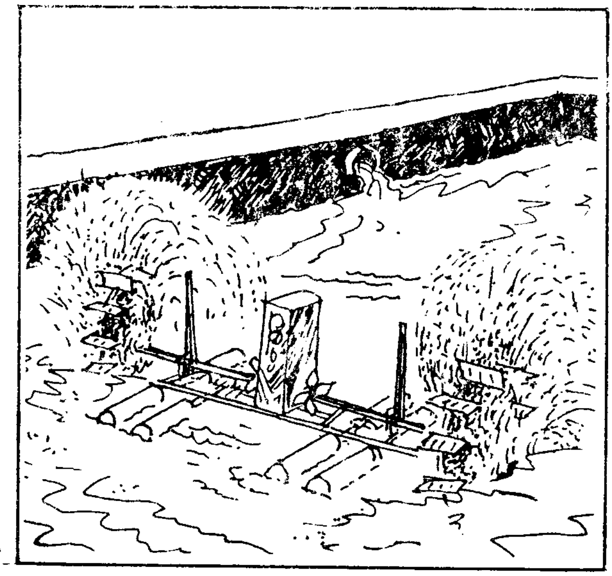
	Management system		
Parameter	Extensive	Semi-intesive	Intensive
Land purcase	No	No	Yes
Capital cost (US$/ha)	None	3,280-3,825	27,322
Production (kg/ha)	179	1,000	5,625
Operating cost (US$/ha)	328	2,721	19,125
Gross profit (%/ha)	929	5,465	30,738
Net profit (US$/ha)	600	2,743	11,623
Breakeven price (US$/kg)	1.83	2.72	3.40

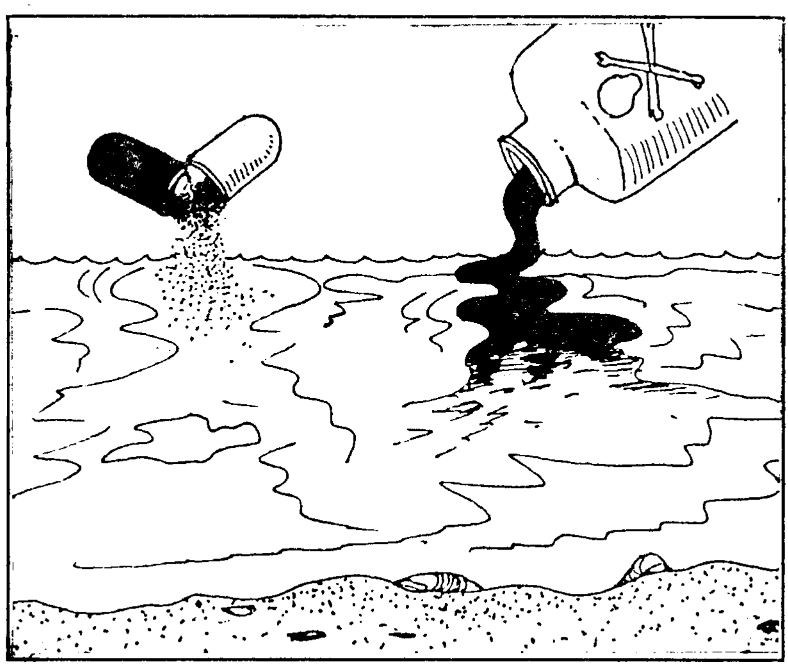
intensive farms had higher profitability compared to semi-intensive farms on a per hectare basis (₱537,000 vs.₱240,000) (US$1:Phil. Pesos 20.6) but a lower profit per kilogram (₱34,12 vs. ₱39.72).*(See page 10 for more on economics of different culture systems.)*

In Indonesia, gross and net profits increase with intensification of culture, but so does the breakeven price (Table 1). Intensive and semi-intensive farms can remain profitable only at selling prices of $4.37/kg and $3.28/kg, respectively. Although traditional and extensive farmers in the Philippines, Vietnam, Sri Lanka, and Bangladesh managed to survive the 1989 *P. monodon* price collapse, many intensive operators in Southeast Asia and Taiwan were pushed to bankruptcy by high production costs and payments due on development loans.

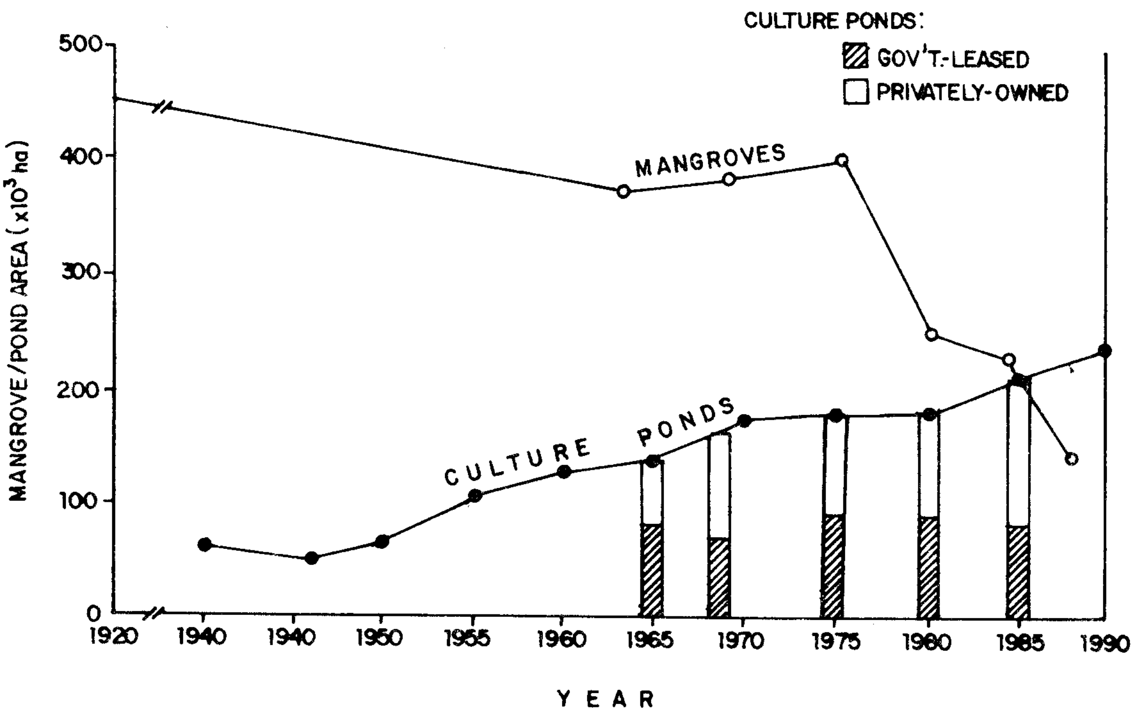
In 1983, intensive shrimp farming in the Philippines required a capital outlay of ₱0.5 million ha-1 ($1:Phil ₱11.1) for pond development compared to only ₱25,000/ha for semi-intensive ponds. Dependent on tidal flow, traditional and extensive farms utilize existing coastal ponds; no land purchase is involved. In contrast, heavy machinery used to construct intensive ponds requires a firm substrate, therefore more inland locations need to be acquired. Similarly, capital costs in Indonesia increase from nil to $27,322/ha, and annual operating costs from $32/ha to $19,125/ha with the shift from extensive to intensive shrimp culture.







Intensive prawn farming and effects on the environment: artificial feeds, high DO requirements, massive water/power requirements, use of antibiotics, pesticides and other chemicals.



Total mangrove area and brackishwater culture ponds in the Philippines. (redrawn by E. Ledesma)

Ecological impacts

The single most important consequence of brackishwater aquaculture in the Philippines is the loss of mangrove ecosystems. Other ecological effects, such as pollution caused by organic matter and nutrient overloading, chemical toxicity, and public health risks, are unique to intensive shrimp farming. In addition to material from the Philippines, the discussion draws from the experience of other Asian countries.

Loss of mangrove ecosystems

A total 58% of fishpond were converted from mangroves in the Philippines as of the late 1970s. In 1969-1984, the reduction in mangrove areas in Ecuador was mainly due to the construction of 21,587 ha of shrimp ponds compared to only 1,152 ha for urban expansion. Around 50% of the total denuded mangrove area of 171,472 ha in Thailand for the period 1961-1987 was converted into ponds. The Department of Fisheries of Malaysia estimates that 21,000 ha of mangroves could be opened up for prawn culture by the year 2000.

The continued expansion of fishponds remained in spite of the proconservation stance of the DENR. Until 1984, the yearly Fisheries Statistics published by the BFAR continued to list mangroves under a section entitled "Swamplands available for development."

Mangrove loss to shrimp ponds which was facilitated by western economic assistance (IBRD, ADB, World Bank, and other multilateral development agencies) may be the dominant cause of the well-documented decline in the abundance of wild shrimp postlarvae in Ecuador. Various studies show a positive correlation between fish or shrimp catches and mangrove or intertidal areas in different parts of the world. They demonstrate a mathematical relationship whose ecological basis may be related to the exchanges of detritus, nutrients, and fauna between mangrove and nearshore habitats.

Organic loading and pollution

Organic matter that settles at the bottom of shrimp ponds forms a thick foul-smelling sludge layer which, after harvest, is either scraped off, or dried and tilled at the bottom to hasten decomposition. Farmers in a rush to make 2.5 to 3 crops a year find this fallow period too time-consuming and instead remove the offensive bottom layer which, eventually loses organic matter and gets deeper.

Intensive monoculture ponds of shrimp or fish show the same general trends as a stressed ecosystem following pollution.

Nutrient enrichment and eutrophication

Assimilation efficiency of food nitrogen is only 45% in cultured *P. monodon*. At FCR of 2, around 87 kg of nitrogen and 28 kg. of phosphorus per ton of shrimp harvested are produced as wastes. Mean concentrations of water quality parameters in Hawaiian shrimp ponds were generally higher in effluent than in influent water. Nitrogen and phosphorus water levels in wastewater discharged from shrimp ponds in Thailand were significantly higher compared to inflow water. Loadings of dissolved nitrogen are important because nitrogen is generally regarded as the phytoplankton-limiting nutrient in marine waters. Yellowtail feces may stimulate growth of the red tide-forming dinoflagellate.

Prevention and Control of Wastes

Prevention and control are the two major approaches in addressing the problems of organic effluents, nutrient enrichment, and diseases in intensive aquaculture. Prevention means good management and husbandry: proper site selection, pond design, pond preparation, water and feeding management.

	Intact/ managed mangrove system	Brackishwater pond culture			
		Milkfish culture	Shrimp farming		
			E	S-I	I
A. Values					
1. Communal ownership of resources	+	-	-	-	-
2. Mangrove products	+	-	-	-	-
3. Coastal protection	+	-	-	-	-
4. Nearshore fisheries production	+	-	-	-	-
5. Domestic food supply	+	+	-	-	-
6. Foreign exchange	±	-	+	+	+
7. Income	+		Limited to middle and upper income classes		
8. Employment	+		Limited to technical and managerial expertise		
9. Competition for land, credit, etc.	-	+	+	+	+
B. Problems					
1. Pollution (inside and outside pond system)	-	-	-	-	+
2. Chemical toxicity	-	-	-	-	+
3. Public health risks	-	-	-	-	+
4. Displacement of native species	-	-	-	-	+
5. Spread of parasites and diseases	-	-	-	-	+
6. Water and soil salinization	-	-	-	-	+

Ecological & socioeconomic values (A) and problems (B) of brackishwater pond culture compared with intact or managed mangrove system. (+ denotes presence; - denotes absence or loss; E - extensive; SI - semi-intensive; I - intensive)

Socioeconomic effects

Some socioeconomic effects, such as loss of goods and services resulting from mangrove conversion, are consequences of brackishwater pond culture in general whether for milkfish or shrimp. However, water salinization and land subsidence, decline in domestic food crops, and competition for credit, land, and other resources are recent occurrences associated with shrimp farming .

Total mangrove and brackishwater culture pond area in the Philippines, 1920-1990

	Mangrove area	Brackishwater culture ponds		
Year	(ha)	Total area (ha)	Increase (ha/yr)	Remarks
1920	450,000			
1940		60,998	1,176 (1941-1950)	
1950		72,753	5,050 (1951-1960)	Fishpond boom Creation of Bureau of Fisheries; US$26 million from IBRD for fishpond development
1960		123,252	4487 (1961-1970)	
1965	362,334			
1970	288,000	168,118	811 (1971-1980)	Conservation phase National Mangrove Committee (1976); Forestry and Fisheries Decreees; 79,000 ha mangroves allocated for preservation after nationwide inventory
1980	242,000	176,231	4,668 (1981-1990)	Shrimp fever Extension of hatchery technology; commercial production of fry and feeds; introduction of intensive farming; $21.8 million ADB project for shrimp and other aquaculture
1988	149,300			
1990		222,907		

*Source: Primavera-Honculada, J. **"A Critical Review of Shrimp Pond Culture in the Philippines".** Reviews in Fisheries Science, 1(2): 151-201 1993.*