

# **ECONOMIC AND TECHNOLOGICAL ASPECTS OF THE INDONESIAN MILKFISH INDUSTRY**

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In this paper, the authors provide a broad overview of the economic and technological aspects of Indonesian milkfish aquaculture based on existing information. In doing so, the authors have brought together in a single report information on the economic importance of milkfish, fry capture and distribution, milkfish grow-out system, economics of production, and milkfish marketing and distribution.

In Indonesia, milkfish is regarded as a high value food item. Because of various constraints to high milkfish yield, Indonesian milkfish ponds are still grossly underutilized. As a consequence, these constraints and the resulting present low per hectare yield level would not be able to support the government's drive toward self-sufficiency in fish in the near future. This is in spite of government assistance which has been mainly production-oriented. By this is meant that in seeking solutions to low per hectare output of milkfish, the emphasis has been or is on technological solutions.

Of equal importance is the necessity to understand the socioeconomics of milkfish production such as the attitudes of producers toward present low yield and the reasons why they are not using more inputs. Government assistance should not be narrowly focused on production alone but should also encompass organized marketing and distribution involving as much as possible the private sector in moving the fish, and continuous follow-up to monitor progress of government projects.

Economic analyses can help to single out research areas which require further attention. For example, out of all the possible factors affecting milkfish yield, which ones are more important? Because government funds are not unlimited, it is important that only the more significant or immediate problems be looked at first.

## INTRODUCTION

Like the Philippines and Taiwan, Indonesia has a long history of milkfish aquaculture. In 1980, the Indonesian milkfish industry was worth US\$31.7 million (US\$1.00 = Rp. 980)<sup>1</sup> and total output was 52 922t. Indonesian milkfish farming covers an area of 182 000 ha, which is roughly 65% of the total area under aquaculture. There are reportedly another 6 million ha of tidal land suitable for brackishwater fish production, some of which is at present under cultivation using salt-tolerant crops or agricultural practices to overcome saline soil conditions.

In a country where the population is growing rapidly, it is but natural for the Government to be preoccupied with food production and employment. The Government's push for increased milkfish production stems from the widely-observed shortage of protein in the diet of the population. The per capita consumption of protein (16 kg), especially that of animal origin, is still far below the nationally determined minimum requirement, and the Government views milkfish production as a very appropriate means to increase animal protein consumption. The Government's goals for milkfish aquaculture are both extensification (expansion of area) and intensification (use of greater quantities and variety of inputs) to increase the supply, generate employment, and improve the incomes and living standards of rural Indonesians.

As in the Philippines, Indonesian milkfish farmers' lack of accessibility to modern technology and pond management methods has been cited as one of the major constraints to achieving high yields. While experiments in Java, Sumatra, and Sulawesi have demonstrated that more than 2 t of milkfish can be harvested annually from a 1-ha pond (DGF 1978), the national average yield is about 450 kg/ha per year, showing at least a fourfold yield gap between actual and potential production levels.

The Indonesian Government, however, has a more modest and realistic target: to increase average yields to 800-1000 kg/ha per year (Jamashita, n.d.; Duncan 1982; Padlan 1979; Anon 1979). Among the numerous recent projects to raise milkfish production and productivity, the Indonesia Brackishwater Aquaculture Production Project (IBAPP) with US\$ 900 000 in USAID support and an equivalent amount of Government counterpart funding deserves special mention. The main objective of the IBAPP is to increase brackishwater pond (*tambak*) production and to create

<sup>1</sup>Throughout this paper the current foreign exchange rate of US\$1.00 = Rp. 980 has been adopted. The Indonesian rupiah underwent two other changes prior to the latest devaluation (US\$1.00 = Rp. 415, US\$1.00 = Rp. 625). Historical price and value data used to convert to US dollars thus reflect the latest exchange rate.

an organizational base upon which *tambak* area expansion can take place (Duncan 1982). The purpose of the International Development Association credit line for intensification and diversification of brackishwater pond production is to assist milkfish farmers to adopt modern technology and management methods for greater productivity. The 8-year (1971-1978) UNDP/FAO Project on Brackishwater Shrimp and Milkfish Culture Applied Research and Training also had increased milkfish production as one of its objectives.

### ECONOMIC IMPORTANCE OF MILKFISH

Milkfish culture has historically been the largest aquaculture industry in Indonesia. Table 1 summarizes the production and the value of production of milkfish from 1967 to 1981. Brackishwater pond production provides employment to at least 60 000 farmers and to approximately the same number of pond caretakers/laborers, excluding secondary, tertiary, and other ancillary employment such as fry collecting, net-making, ice-making, fish marketing, and milkfish processing (e.g., smoked milkfish). Off-farm employment resulting from milkfish farming is significant.

In Indonesia, milkfish, locally called *bandeng*, is a high value food item. Unlike in Taiwan and the Philippines, where the milkfish price has recently declined, the price in Indonesia has increased. The decrease in price in Taiwan and the Philippines has been due in part to the increasing availability of tilapia *Oreochromis* sp., especially in the Philippines, where tilapia competes with milkfish. Moreover, there is lower consumer preference for tilapia in most parts of Indonesia. It will be some time before tilapia can begin to supplant the role of milkfish in Indonesia. Sullivan (1981) estimated that with the present level of technology and limited expansion into new *tambaks*, a shortfall of 2525 t of milkfish is projected for 1985 given current production and consumption patterns. But matching production regions with consumption centers is important.

A socioeconomic profile of milkfish farming in Indonesia showed that the majority of the farms were family-owned and operated. Many farms were small, making hired labor less necessary, out of 1.7 workers per farm, 1.4 were supplied by family labor (Sugito 1978). The average farm size was about 2.5 ha.

In Java, the range in farm size was from less than 1 ha to more than 15 ha. The size of farm operations was defined as small (<2 ha), medium (2-5 ha), or large (>5 ha) (Sugito 1978). According to the most recent data based on the 1973 Milkfish Census for Java, 56.9% of small farms accounted for 20.2% of the total area and 26.3% of the total milkfish production. At the other extreme, large farms accounted for 44.8% of all areas under milkfish and 36.4% of the total milkfish output. According to Poernomo (1974), the average farm sizes in East, West, and Central Java were 3.62, 2.41, and 1.42 ha, respectively. In Central Java, the local government has decreed that no farmer can own more than 2 ha, but farmers who have more than 2 ha overcome the ruling by registering land under the names of the wife or children (Wirutallingga and Basmi 1974).

The island of Java, by far the most densely populated, has 60% of the country's people as well as more than 50% of the total area of brackishwater ponds, which are generally older than those in the other islands. South Sulawesi's average annual yield

Table 1. Production and value of production of milkfish, Indonesia, 1967-1981 (Fisheries Statistics of Indonesia 1982).

Year	Total area (ha)	Total production (t)	Total value (US\$ million)	Average price (US\$/kg)	Milkfish production as percent of total (%)		
					Fish supply	Brackishwater aquaculture	All aquaculture
1967	165 007	36 320 <sup>a</sup>	n.a. <sup>b</sup>	n.a.	3.1	64.0 <sup>c</sup>	26.4
1968	172 054	27 860	n.a.	n.a.	2.4	64.0	24.0
1969	177 061	33 200	n.a.	n.a.	2.7	64.0	28.9
1970	179 911	35 800	n.a.	n.a.	2.9	64.0	26.6
1971	182 073	38 900	n.a.	n.a.	3.1	64.0	28.1
1972	178 297	32 800	n.a.	n.a.	2.6	64.0	25.0
1973	184 090	38 439	8.34	0.22	3.0	63.6	27.6
1974	186 167	41 650	8.60	0.21	3.1	62.4	28.4
1975	182 701	44 692	11.71	0.26	3.2	56.7	27.1
1976	164 594	44 027	15.00	0.34	3.0	54.9	28.5
1977	174 605	48 641	20.35	0.42	3.1	55.5	30.4
1978	171 544	48 287	19.99	0.41	2.9	54.9	28.2
1979	181 792	46 187	24.23	0.52	2.6	49.3	25.3
1980	188 601	52 922	31.73	0.60	2.9	54.1	26.4
1981	192 490	—	—	—	—	—	—

<sup>a</sup>Figures for 1967-1972 are estimates based on the species composition of brackishwater culture of milkfish, shrimp, and other species (e.g., tilapia). Sugito (1978) reported that milkfish, on the average, comprised 64% of the total output from brackishwater ponds.

<sup>b</sup>n.a. = not available.

is the highest in the country (Pownall 1975), and the lowest is recorded for Kalimantan. There is wide variability in average yield from area to area depending on the stage of development of the ponds and on local conditions.

*Tambak* real estate is more valuable than rice land; for example, in Central Java a hectare of *tambak* was worth Rp. 300 000 in 1973 while the price was only Rp. 200 000/ha for rice land (Wirutallingga and Basmi 1974). At present a hectare of milkfish pond is worth Rp. 5 million, or 17 times more than the value in 1973.

For 1980, the Directorate General of Fisheries (DGF) reported that brackishwater pond operators applied a total of 2600 t of organic fertilizer (or 15 kg/ha per year), 2431 t of inorganic fertilizer (or 13 kg/ha per year), and 44 t of pesticides (or 0.2 kg/ha per year). Thus, it is clear that, on the average, Indonesian milkfish producers are still not applying adequate levels of inputs to increase the output. It is only recently that the Government has made available subsidized fertilizers to milkfish producers; prior to 1975, the fertilizer subsidy scheme was available only to agricultural farmers. Even so, out of a total of 63 247 milkfish farming households, 45% have not used any type of fertilizer.

#### FRY CAPTURE AND DISTRIBUTION SYSTEM

Although a milkfish hatchery is now under construction in Gondol, Bali, it will be several more years before artificially spawned fry become available for stocking ponds. The basis of production continues to be wild fry, the catch being estimated at 700-800 million fry/year. Milkfish fry appear and are collected in coastal and estuarine waters from April to June and from September to December. According to popular belief, fry caught early in the latter season and also those caught off the island of Madura fetch higher prices because of higher survival rates. The farmers claim that the quality and vigor of these fry are higher. They attribute the difference in quality to skillful handling of the fry.

Historically, West and Central Java have been fry deficit areas, and Bali, South Sulawesi, Halmahera and Aceh Madura have been surplus fry areas, the latter traditionally supplying the former. Figure 1 shows the locations where milkfish fry are present and where milkfish culture is concentrated. For the most part, these areas are along the northern coast of Java and Sumatra and along the coasts of South Sulawesi.

The most common method of collection depends on concentration of the fry by a device called a *belabor*, which consists of cut, dried leaves of banana or certain kinds of grass woven into a long rope. The *belabor* can either be used as an encircling device or staked in the water. The fry are collected by a triangular fine mesh push net or a dipper. Satisfactory quantities of fry are caught during high tides in the mornings and evenings, especially during the full and new moon, which coincide with spring tides.

In Indonesia, milkfish fry are transported in plastic bags and either clay pots (*periuk* or *kepeng*) or containers called *waluh* woven out of split bamboo bark or the leaves of the fan palm (*siwalan*) and plastic bags. To be able to hold water, these woven containers are coated inside with tar or cement. A *kepeng* with a diameter of 40 cm can hold 1 000 fry, while a 70-80 cm diameter *waluh* can hold 10 000 fry for a long haul and 30 000 fry for a short distance.



Interisland transportation of fry is mostly by water, sometimes by air, but, in a country with 13 677 islands, land transportation is understandably restricted.

At the beach, the fry landed are sold to *welijos*, the first link between the fry collectors and middlemen in the fry marketing chain. In turn, the *welijos* sell fry to *juragan jalans* (literally "walking middlemen"), who in turn sell them to *juragan duduks* (literally "stationary or sitting middlemen"). The milkfish farmers obtain their fry supply from the *juragan duduk*. This, however, does not mean that the milkfish farmers are restricted to buying from the *juragan duduk*; they have the option to buy from any of the above market intermediaries, and in fact some have been reported to deal directly with fry collectors or *welijos*. The common marketing practice within a province, however, is the system described above; among provinces the system is slightly different (Fig. 2). Under the present milkfish pond management system (underdeveloped, developing, and advanced), about 1.2 billion fry are required to stock the 182 000 ha of milkfish ponds. The main sources are Aceh in Sumatra, Maluku, Bali, Nusa Tenggara, and South Sulawesi. These fry are largely shipped to Java. At present only about 740 million fry are landed (Fig. 3). There is thus a shortage of about 460 million fry.

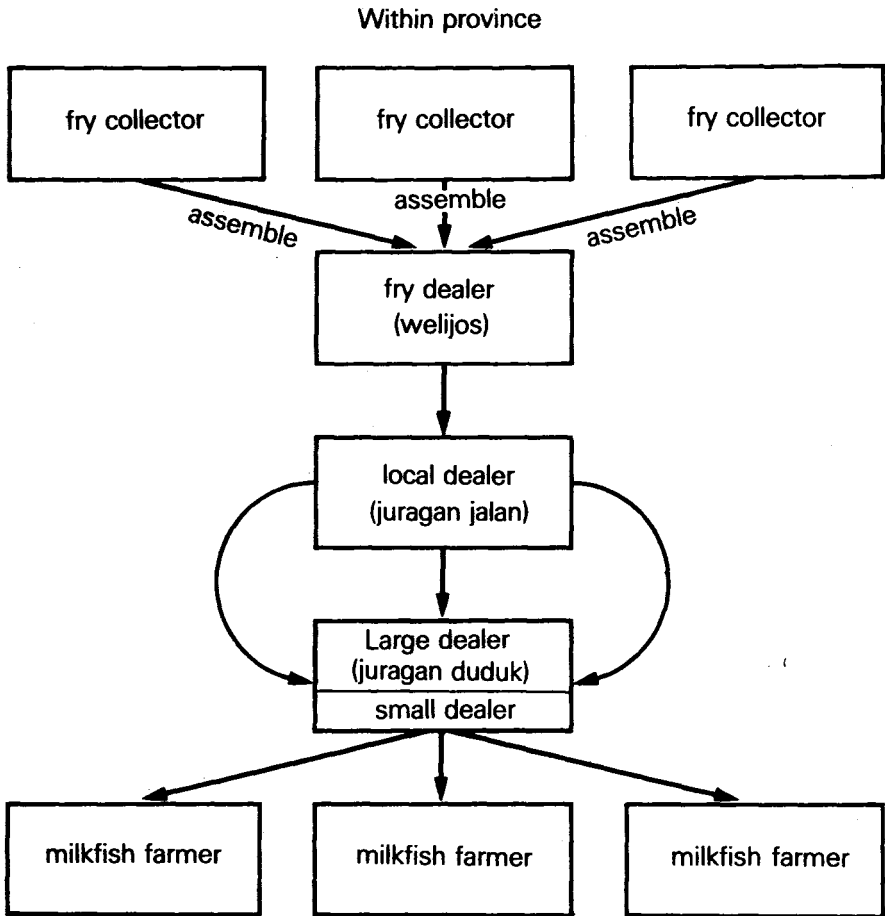
#### GROW-OUT SYSTEM

Distinguishing the meanings of two Indonesian terms will help in understanding part of the problem of perennially low milkfish yields in the country. The first is the *tambak*, in which milkfish are traditionally grown. Milkfish culture started about 600 years ago in mangrove swamps using traps (Cremer 1983). The next step was to enclose the water in a tidal flat or mangrove area to trap the milkfish and allow them to grow. This was the *tambak*. Because it is an enclosure constructed with loose mud, and no digging is done, the water within is only as deep as it was before the embankment was built. Furthermore, it is affected by changes in the tide levels. Other Indonesian words used to describe the *tambak* are *petak*, *pematang*, and *batas*, meaning bunds or boundaries. The bunds retain the water and fish within the enclosed *tambak*. Two other words for *tambak* are *benteng* and *empang*, which connote "walling-off" a water area to retain water and fish. No digging below the ground level is implied, and the depth of the water is necessarily shallow.

On the other hand, the word *kolam* connotes digging, and the bottom of the *kolam* is well below the surface of the ground. A *kolam* is thus a dug-out pond while a *tambak* is a levee-type pond. The dikes of the *kolam* are usually stronger and higher, while the bunds of the *tambak* are low and not as well constructed.

*Tambaks* are found in coastal areas while *kolams* are situated inland. Slamet (1983) stated that the word *tambak* is normally reserved for a brackishwater pond system and *kolam* is specific to freshwater systems.

In East Java, milkfish is also grown in padi field and is referred to as *sawah tambak*, because the farmers there liken *tambaks* to padi fields (*sawah* is the Indonesian word for rice field), implying shallowness. In describing the conditions of Indonesian milkfish ponds, Padlan (1979) pointed out that it is not unusual to see water only in the peripheral ditches and in the longitudinal canals purposely excavated to hold the milkfish during neap tide. Furthermore, he added that



maintenance of adequate water depth especially during the dry season is almost impossible. It appeared to him that shallow water is not yet recognized as a major problem and that the situation is actually desired. Nevertheless, experiments to increase milkfish yield in shallow, undrainable ponds have shown that yields can be substantially increased over existing levels.

Fish yields from *kolams* are generally higher than those from *tambaks*, due in part to the difference in the water depths of the two systems<sup>2</sup> and, accordingly, to differences in stocking rates. Unlike in Taiwan, supplementary feeding is not widely practised in Indonesia. The economic basis of production in Indonesia is the primary productivity of the shallow water column, usually without organic or inorganic fertilization (Djajadiredja and Poernomo 1971). Also, predatory fish and other unwanted species

<sup>2</sup>According to Schuster (1952), 21% of the *tambaks* in Java are simply too shallow to be productive. Although Schuster made his observations in the 1950s, the same conditions prevail in many areas to this day.



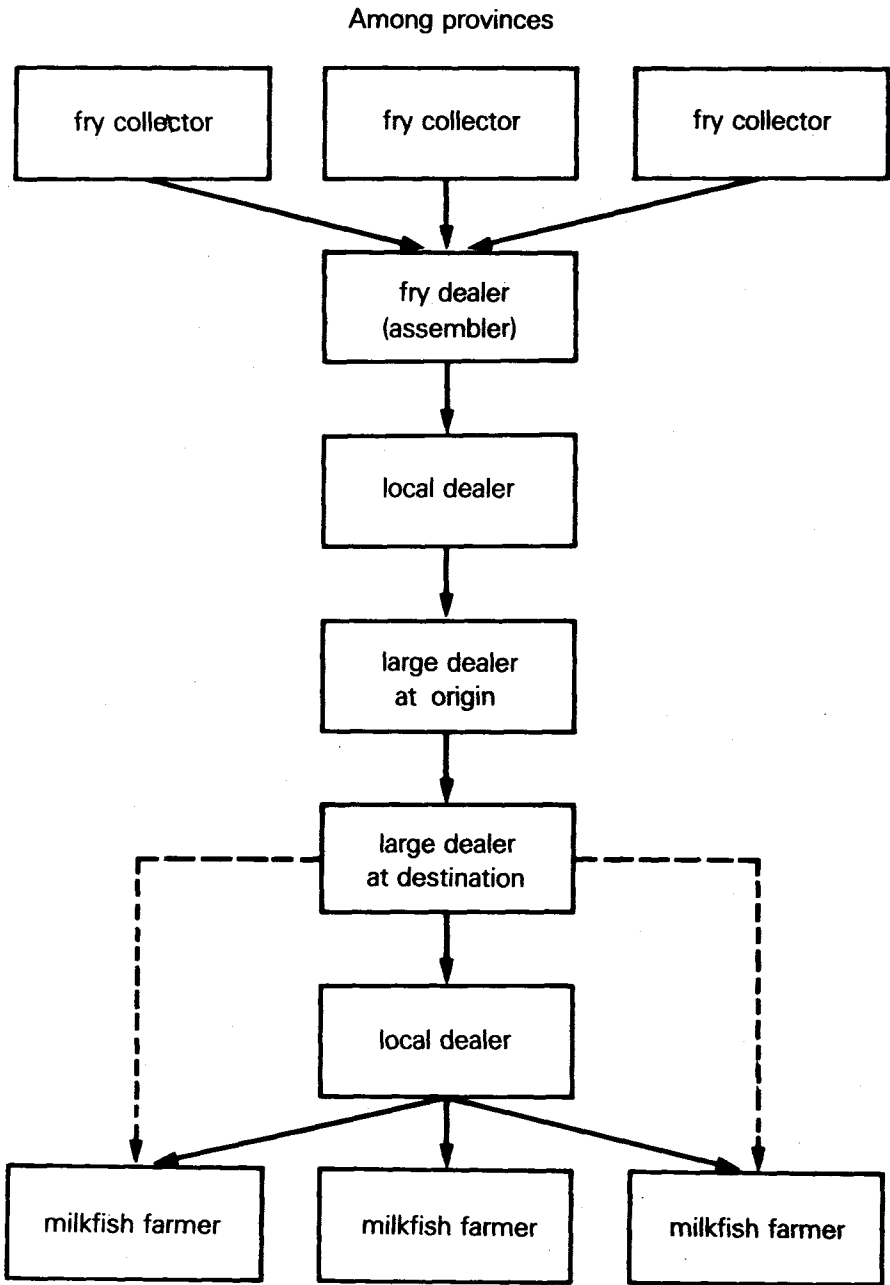
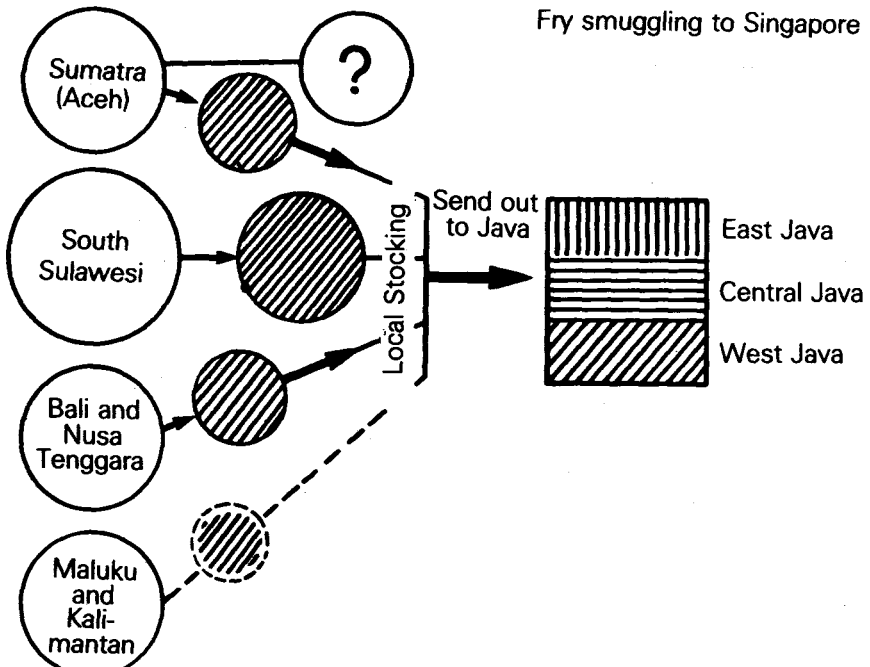


Fig. 2. Indonesia milkfish fry marketing system.



Fry ground	Number of fry (million)	Fry ground	Number of fry (million)
Sumatra (Aceh)	143.6	Central Java	104.4
South Sulawesi	182.7	Bali and Nusa Tenggara	11.3
East Java	160.0	Kalimantan	n.a
West Java	138.0	Maluku	n.a

**Total 740.0 million**

Fig.3. Source and distribution of milkfish fry, 1979.

(pests) are not properly eradicated; they not only compete for the available food in the water column but also prey on the milkfish. Milkfish fry are especially vulnerable; the shallow water does not help them to escape, either.

*Tambaks* are shallow for another important biological reason. *Kelekap* or microbenthic algae — milkfish pastures — require shallow water to grow and flourish; water depths greater than 20 cm inhibit the growth of *kelekap*. *Kelekap* is by far the most important traditional, preferred source of food for milkfish. Because of the water depth requirement of this type of fish food, such ponds thus become structurally shallow. If microbenthic algae are the basis of production, milkfish ponds cannot be very deep. Perhaps, kitchen ponds can be considered as a way out.

On the other hand, if plankton (phyto- and zoo-) is the type of food to be relied upon for milkfish growth, ponds can be made deeper, because plankton grows well in

deep water, Milkfish farmers in Taiwan and to a small extent in the Philippines have already taken advantage of this water depth requirement for different food types to raise milkfish productivity.

#### TYPES OF POND SYSTEM

Although brackishwater aquaculture in Indonesia has been in existence since the 15th century, pond layout as well as pond management still vary greatly in different localities. Layout started from a very simple method wherein each pond compartment was connected to each other because no separate water gates were made (serial water supply); in the present, improved system each compartment has a separate gate, nursery ponds, transition ponds, rearing ponds, catching ponds, and a water supply system.

In East Java, milkfish farmers have designed two unique pond systems which are now widely used. These are called the *taman* and *porong* type of ponds (Fig. 4). The principal difference between these two types of pond is that the location of the catching pond is at the middle in the *taman* type and adjacent to the main water supply canal in the *porong* type. Temporary nursery ponds or *ipukan* are provided in both cases, where the fry are stocked and nursed for one week. Transfer or release of the fry into the rearing ponds is done simply by breaking the dikes. Usually the *ipukan* is located in the center or at the extreme end of the rearing pond.

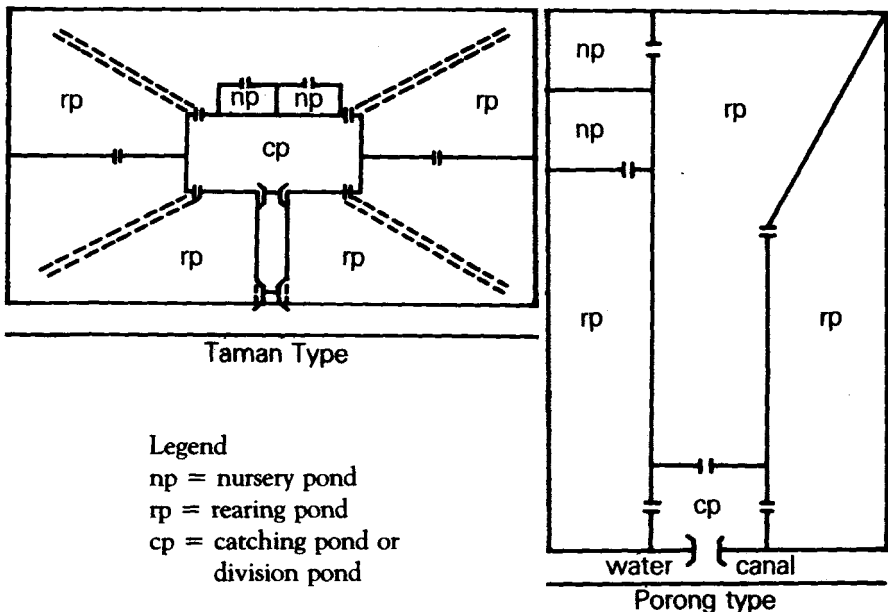


Fig. 4. Layout of *porong* and *taman* types of milkfish ponds.

Many milkfish farms are small, ranging from 0.25 to 6.0 ha. Recently, several modifications in pond design have been made such as well-built peripheral and partition dikes laid out in straight patterns, regularly shaped compartments of manageable size, and better situated supply and/or drainage canals and gates to facilitate independent water management for each compartment (parallel system). The bottoms are cleared of tree stumps and provided with deeper periphery canals.

The nursery ponds in the improved system, however, are still very simple and are located at the middle of each rearing pond. They are constructed by making temporary dikes. The fry are nursed there for about 3 weeks, then released into the rearing ponds by cutting the dikes. Natural food is grown through preparation of the pond bottom, fertilization, and pest control, while shelter is also provided to protect the fry against the heat and heavy rains. Two to three crops per year can be grown.

### ECONOMICS OF PRODUCTION

Milkfish production rates vary from area to area, largely determined by the levels of management: rates of stocking, rates of fertilization, control of predatory fish and other pests, number of croppings per year, etc. (Chong et al 1982). Before a cost and returns analysis of milkfish culture is presented it is worthwhile to examine the price differential between the producer and consumer (Table 2). While milkfish farmers receive an average of 75% of the final consumer price per kg in Aceh, producers in Java receive only 46% (Sullivan 1981), the implication being that milkfish farmers in Java must make sure that their production costs are less than 46% of final retail price for their operations to be profitable.

#### Cost and Returns Analysis

The lack of more recent data on costs and returns of milkfish production in Indonesia prompted the reconstruction of the cost and returns analysis in Table 3

**Table 2. Average monthly milkfish prices in 20 provinces, 1982**  
(Directorate General of Fisheries, unpubl. data).

Month	Producer price (US\$/kg)	Consumer price (US\$/kg)
January	1.05	1.38
February	0.84	1.18
March	0.93	1.11
April	0.96	1.13
May	1.07	1.22
June	1.27	1.47
July	0.96	1.16
August	1.07	1.28
September	0.77	1.12
October	1.11	1.41
November	0.44	0.63
December	1.01	1.21
Average	—	1.26
Lowest	—	0.80
Highest	—	2.05

**Table 3. Cost and returns profile for milkfish.**

Partial operating costs	Rp
9000 pcs. milkfish fry @ Rp. 15 each	135 000
390 kg urea @ Rp. 100/kg	39 000
1000 kg cow dung @ Rp. 10/kg	10 000
200 kg rice bran @ Rp. 20/kg	4 000
195 kg triple superphosphate @ Rp. 100/kg	19 500
150 kg tobacco dust @ Rp. 25/kg	3 750
1000 kg rice chaff @ Rp. 3/kg	3 000
Subtotal	214 250
Returns	
2168 kg of milkfish @ Rp. 650/kg	1 409 200
Gross returns	1 194 950

based on government experiments on the intensification of milkfish production. The costs and returns are synthesized based on the set of recommended husbandry practices presented by Djajadiredja and Poernomo (1971). The per crop application of 130 kg/ha of urea, 65 kg/ha of triple superphosphate, and 1000 kg/ha of rice chaff, among others, gave the highest yield in a series of experiments—2168 kg/ha per year or 542 kg/ha per crop. The stocking rate was 3000 fry/ha per crop. The more progressive farmers were adopting an improved technique in which fingerlings were used. The milkfish were harvested after 90 days. 1982 prices for inputs and output have been used to reconstruct the cost and returns profile. (Note that this is not based on any actual farm data but has been synthesized using suggested recommendations.)

### Profit

The gross returns represent returns to management, land, labor, and capital. No costs for repair and maintenance, depreciation, marketing, taxes, or other miscellaneous inputs such as fuel have been included. Thus, if we deduct the cost of labor (wages), cost of capital (interest), cost of land (rent), and cost of management (owner-operator's salary) as well as repair and maintenance, depreciation, etc. from Rp. 1 194 950, we will arrive at the net profit of milkfish production.

As a measure of profitability, Sullivan (1981) reported that the returns to management and capital for milkfish farming were about Rp. 190 000/ha per year and for rice-cum-fish farming Rp. 210 000/ha per year.

### MARKETING SYSTEM

Post-harvest handling of milkfish is as important as fry handling and grow-out in ponds because, if post-harvest handling and marketing are not given proper attention, gains made at the earlier stages of production will be lost. In Indonesia, pond-reared fish are normally sold fresh in local markets (Cremer 1983). Milkfish

farmers generally sell their produce on the farm site (pond site market). According to Slamet (1983), milkfish are first iced when they change hands from the producer to the middleman. In fact, Slamet points out that the milkfish are already dead when they are packed into baskets to be brought to the market. Thus, post-harvest losses can become large because the milkfish are not iced immediately after they are harvested.

Indonesian milkfish farmers report that they do not view icing as part of their production costs or responsibilities. Instead, it is the middlemen who have to assume such costs, in contrast to the marketing practice in Taiwan or the Philippines. Also, in Indonesia no sorting is carried out on the farm; sorting into different size categories is done only at the market. This grading into different size categories overlooks the keeping quality aspects of fish.

Milkfish are usually sold within 3-4 days after harvest. Sales are often seasonal, declining from October to March when increased marine fish landings depress market prices (Cremer 1983). Also, Indonesian milkfish farmers do not have access to market price information or similar market intelligence. Wherever transportation linkages are developed and milkfish can be shipped economically from island to island or from one area to another, they are sent out from the local markets. Because of the distances separating the different islands, milkfish markets in Indonesia are largely localized.

With localized markets, any effort to encourage farmers to increase their output runs into serious marketing problems, because the increased output cannot be disposed off easily without depressing the price. Sullivan (1981) reported that the milkfish intensification project in Aceh had lost momentum and milkfish farmers had cut back on production because of low prices.

The importance of marketing and market development should thus not be overlooked in any effort to increase production. Aquaculturists should learn from the marketing problems of the Green Revolution.

### CONCLUSION

In Indonesia, milkfish is regarded as a high value food item. Because of various constraints to high yields, the *tambaks* are grossly underutilized. These various constraints include but are not limited to the following: (1) limited application of improved technology, (2) less than optimum stocking rate of fry, (3) inadequate application of fertilizers, (4) high mortality rate, (5) high interisland transportation costs, (6) relatively shallow and silted ponds, (7) lack of incentives and adequate economic returns because of low productivity and direct competition from marine fish.

support the Government's drive toward self-sufficiency in fish in the foreseeable future, in spite of Government assistance, which has been mainly production-oriented. Because of marketing difficulties, many milkfish farmers who had participated in the Government intensification program have discontinued intensifying their production operations. Government assistance should not be narrowly focussed on production alone but should also encompass organized marketing, distribution, and continuous follow-up to monitor the progress of Government-initiated and -assisted projects.

More rigorous economic analyses (micro- and macroeconomic studies) of the industry are clearly needed to pinpoint areas in which the Government can contribute to fostering greater growth of the industry. Economic analyses can also help to single out research areas which require further attention. For example, out of all the possible factors affecting milkfish yield, which ones are more important? Because Government funds are not unlimited, it is important that only the more significant or immediate problems be looked at first.

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